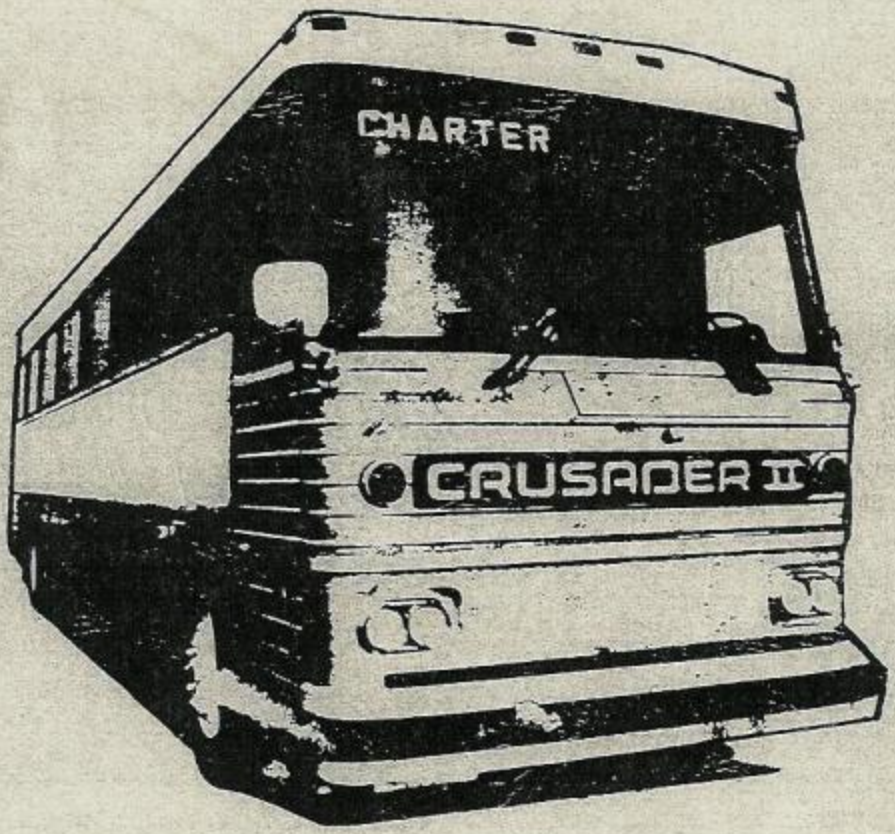
MC-9
CRUSADER II



MAINTENANCE MANUAL

January 1989

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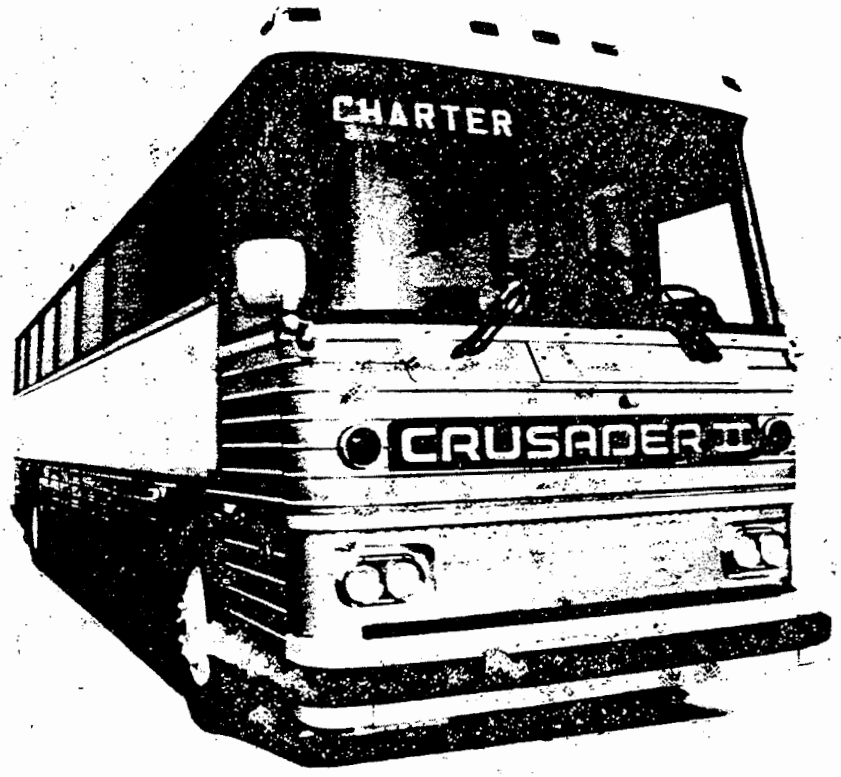
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MC-9 CRUSADER II

MAINTENANCE MANUAL

January 1989



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MOTOR COACH INDUSTRIES LTD.
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MANUFACTURERS OF INTERCITY COACHES

TRANSPORTATION MANUFACTURING CORPORATION
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MANUFACTURERS OF INTERCITY COACHES, TRANSIT BUSES & ROBOTIC TRAILERS

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MC-9 MAINTENANCE MANUAL

SECTION INDEX

Front Axle	1
Rear Axle	2
Body	3
Brakes & Air System	4
Clutch	5
Cooling System	6
Electrical System	7
Engine	8
Fuel System	9
Lubrication	10
Steering	11
Suspension	12
Transmission	13
Propeller Shaft	14
Wheels, Hubs & Tires	15
Heating & Air Conditioning	16
Lavatory	17

WELDING CAUTION

Since welding is a procedure which may be carried out either as allowed (explicitly or implicitly) by instructions in this manual or carried out by an independent decision of the coach owner/operator, the following information pertaining to welding should be read before beginning any welding procedure. The prohibitions and requirements contained therein must be followed during the welding procedure.

1. Welding must be done only by a qualified and experienced person.
2. Adequate ground contacts and barriers must be positioned as required to protect components (wiring, brake lines, hydraulic lines, etc.) from damage due to heat, contact by weld splatter arcing or other potentially damaging events associated with welding.
3. On any coach, turn battery switch to "OFF."
4. For coaches equipped with a battery equalizer, after performing step 3 above:
    a. Disconnect the ground at the equalizer.
    b. Disconnect the battery leads.
5. If coach has ATEC or DDEC, remove the ATEC/DDEC power control fuses.
6. Any applicable welding instructions or prohibitions given by a procedure must be heeded.

Date January 1989

MC-9 MAINTENANCE MANUAL

INTRODUCTION

This manual contains operation, maintenance and overhaul information on MC-9 Model Coach. Information in this manual pertains to standard and commonly used optional equipment.

Vehicle operation from the driver's standpoint is contained in a separate operator's manual. Detroit Diesel engine information is found in a separate service manual. Allison transmission information is contained in the appropriate vendor service manual which, like the engine manual, is supplied separately.

All information contained in this manual is based on the latest product information available at time of publication. We reserve the right to make publication changes at any time.

HOW TO USE THIS MANUAL

This manual is divided into major sections in the sequence shown on the section index. All major sections are divided into sub-sections containing descriptions, operation, maintenance, replacement, overhaul and specification information on related systems and components. A section index appears on the first page of each major section.

PAGE AND ILLUSTRATION NUMBER

Manual pages and illustrations are numbered consecutively within each major section.

SPECIFICATIONS

Service data, torque limits and tolerances are listed at the end of most sections under the heading "Specifications." Manufacturer's model or part numbers are provided where applicable for component identification. Detail service part numbers must be obtained from the MC-9 Model Parts Manual.

SERVICE INFORMATION BULLETINS

Service Bulletins are issued, when required, to supplement or supersede information in this manual. Information in the bulletins should be noted and filed for future use.

CUSTOMER SERVICE

Universal Coach Parts of Northlake, IL and Motor Coach Industries, Ltd., Service Parts Division of Canada, know your coach best and are interested in your complete satisfaction. Both offer genuine factory parts for this MC-9 Model and all other TMC/MCI Coach Models.

Service departments in both Roswell, N.M. (U.S. service) and in Winnipeg, Canada (all Canadian service) stand ready to serve you. Their addresses are:

Transportation Manufacturing Corporation
Service Department
P.O. Box 5670 (R.I.A.C.)
Roswell, N.M. 88202-5670

Motor Coach Industries, Ltd.
Service Parts Division of Canada
1149 St. Matthews Ave.
Winnipeg, Manitoba, Canada R3G0J8

Proper maintenance is important to the safe and reliable operation of the MC-9 Model coach. The service procedures recommended and described in this manual are effective methods for performing service operations. In some instances, the use of special tools is recommended. These tools should be used when and as recommended.

Various WARNINGS, CAUTIONS and NOTICES are contained in this manual. They should be read carefully to minimize the risk of personal injury or the possibility that improper service methods may be used which could damage the coach and render it unsafe. It is important to note that these cautions and notices are not all inclusive. We could not evaluate and advise users of all conceivable ways in which service may be done or of the possible hazardous consequences of each way. We have not attempted to do this. Therefore, anyone who uses a service procedure or tool not recommended by the manufacturer should first satisfy himself that neither his safety nor vehicle safety will be jeopardized by the particular method he selects. REFER TO PAGE ii FOR CAUTIONARY INFORMATION PERTAINING TO WELDING.

MC-9 MAINTENANCE MANUAL

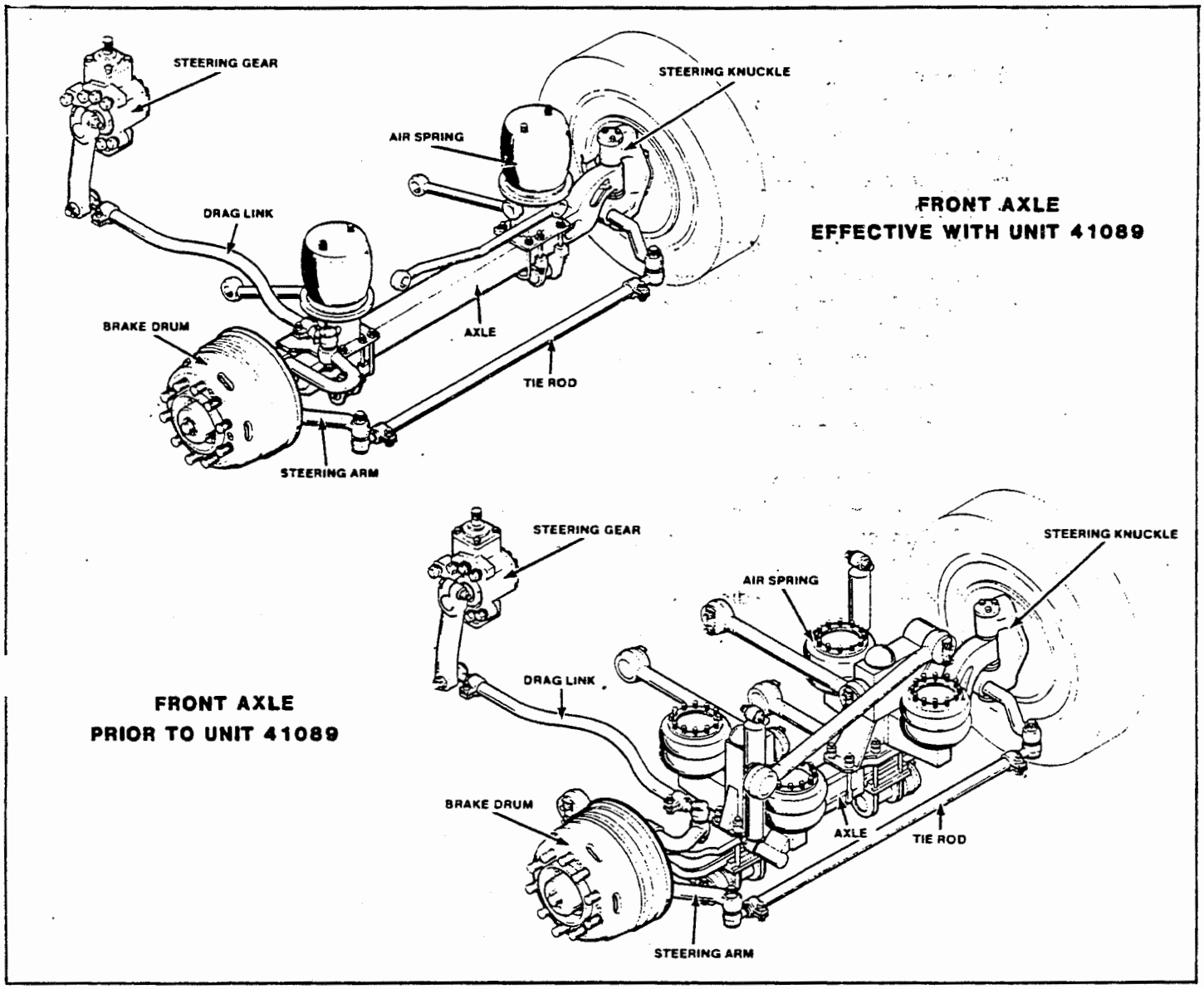


Figure 1-1. Front Axle Assemblies.

FRONT AXLE ASSEMBLY

DESCRIPTION

Effective with unit 41089 the front axle assembly is a tubular type of Reversed Elliot design. Axle construction consists of a tempered seamless steel tube with forged steel king pin ends. On units prior to 41089, the front axle is a forged steel drop center I-beam type. King pin ends are integral parts of the axle center. See figure 1-1.

Steering knuckles have grease fittings in both king pin bosses for lubrication of the knuckle bushings. The bushings are of the "Easy Steer" type on all models after September 1986. Prior to that, the bushings are bronze. Covers and plugs prevent dust and moisture from entering bushings and serve as seals.

The brake shoe spider is doweled and bolted to the steering knuckle. Dowel pins are also used to locate air suspension mountings.

The two steering knuckle assemblies are connected to each other by a tie rod. Tie rod is threaded at each end and held in position by clamp bolts. Right-hand and left-hand threads are provided on the tie rod to facilitate toe-in adjustment. Stop screws installed at each end of axle center limit turning angle of front wheels.

On the tubular style axles, to detect development of fatigue cracks, approximately two quarts of diesel fuel are installed in the hollow tube section. Any axle which leaks should be replaced.

MC-9 MAINTENANCE MANUAL

Steering knuckles are bushed in the upper and lower pin bosses so that they may turn freely about the pins. Bushings are grooved on the inside to allow grease to flow uniformly to high-pressure areas. Grease fittings are installed at both upper and lower king pin bosses.

On the earlier MC-9 front axles the tapered steering knuckle pins are drawn into the axle center by tightening the nut at the upper end of the pin. On the later MC-9s a straight type knuckle pin is used. The straight type pin is held in place by draw keys in the knuckle.

Wheel bearings, air suspension, steering and brake parts which are mounted on the front axle are described in the applicable sections of this manual.

LUBRICATION

Periodic lubrication according to the recommendations in the lubrication section of this manual should be carried out. Points which require lubrication are the steering knuckle pins, tie-rod ends and drag link ends. These are provided with grease fittings for pressure lubrication.

MAINTENANCE

Periodic inspection of the front axle assembly should be made to see that all bolts are tight and that no damage or distortion has taken place. Suspension support stud nuts, U-bolt nuts, tie-rod arm and steering arm nuts, and stop screws should be checked and tightened if necessary to the torque specifications shown at the end of this section. Attention should also be given to the condition of the steering knuckle pin and bushings. If excessive looseness is found at this point, the bushings and pins should be replaced.

The axle manufacturer recommends that the bronze or "Easy Steer" king pin bushings be replaced when the range of side-to-side tire movement reaches .030 inch or when the bushings are worn to a maximum of .010 inch on their diameter.

NOTE: These measurements are made with the wheel bearings tightened on the spindle.

With new bushings installed, the range of side-to-side tire movement should not exceed .010 inch maximum. Refer to Figure 1-2.

Looseness in the steering linkage under normal steering loads is sufficient cause to immediately check all pivot points for wear, regardless of accumulated mileage. Steering linkage pivot points should be checked each time the axle assembly is lubricated. If any indication of lateral movement is found, cross tube ends should be removed for inspection. Looseness at the steering linakge pivot points can be visually detected during movement of the vehicle steering wheel.

Steering knuckles, king pins, and bushings may be replaced without removing the axle from the coach.

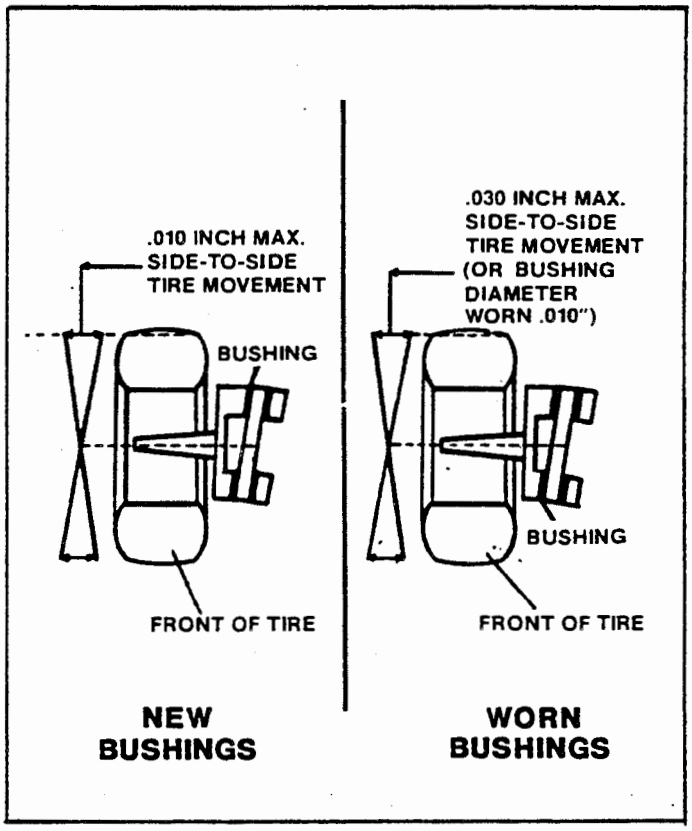


Figure 1-2. Side-To-Side Tire Movements With New And With Worn King Pin Bushings.

If extensive overall work or straightening of the front axle center is necessary, the axle should, of course, be removed.

WARNING: Do not attempt to repair, remove or reinstall front axle with the vehicle supported by jacks only.

FRONT AXLE REMOVAL (Prior to unit 41089)

To remove the entire front axle assembly first block the rear wheels to prevent the vehicle from rolling. Raise the front end of the coach with jacks until the bottom of the coach body is approximately 18" (457.2 mm) from the floor. Block the body in this position as indicated in Section 3 under Coach Jacking Points.

CAUTION: Do not raise the body in such a way that the entire weight of the front axle will hang on the suspension bellows assemblies. Damage to the bellows may result.

1. Remove tires and wheels from axle. See Section 15.

2. Exhaust air pressure from the suspension air tank by opening the drain cock at the bottom of the air filter.

3. Disconnect the height control valve link, and pull down on height control valve arm to exhaust air from the front inner beams.

4. Disconnect the hose from the front brake chambers.

5. Disconnect the steering drag link.

6. Disconnect both ends of all radius rods as outlined in this section under Radius Rods.

7. Remove nuts from all bolts attaching air springs to the bracket assemblies.

8. Remove shock absorbers as outlined in this section under Shock Absorbers.

9. Lower the axle assembly on jacks until air spring bead ring bolts are cleared of the suspension supports. The axle can now be carefully removed from under the vehicle.

Reinstallation of the axle assembly is the reverse of removal. Make sure that air springs mounting pads on axle towers are clean.

FRONT AXLE REMOVAL (Effective with Unit 41089)

To remove the entire front axle assembly first block the rear wheels to prevent the vehicle from rolling. Raise the front end of the coach with jacks until the bottom of the coach body is approximately 18" (457.2 mm) from the floor. Block the body in this position as indicated in Section 3 under Coach Jacking Points.

CAUTION: Do not raise the body in such a way that the entire weight of the front axle will hang on the suspension bellows assemblies. Damage to the air springs may result.

1. Remove tires and wheels as detailed in Section 15.

2. Exhaust air pressure from the suspension air tank by opening drain tank at bottom of the air filter.

3. Disconnect the height control valve link, and pull down on the height control valve arm to exhaust air from the front inner beams.

4. Disconnect the hose from the front brake chambers.

5. Disconnect the steering drag link.

6. Disconnect both ends of all radius rods as outlined in this section under Radius Rods.

7. Remove nuts from all bolts attaching air springs lower bead rings to the axle tower.

8. Remove shock absorbers as outlined in this section under Shock Absorbers.

9. Lower the axle assembly on jacks until air spring bead ring bolts are cleared of the suspension supports. The axle can now be carefully removed from under the vehicle.

Reinstallation of the axle assembly is the reverse of removal. Make sure that air springs mounting pads on axle towers are clean.

STRAIGHTENING AXLE CENTER - Before Unit 41089

The earlier MC-9 front axle center is a steel forging, heat treated for strength and resistance to bending and torsional strain. If the center is bent or twisted less than approximately 5 degrees from the original shape, it may be straightened. However, it is recommended that this work be done only by mechanics who are thoroughly familiar with such operations and where the proper facilities are available. Parts which are distorted more than approximately 5 degrees from the original shape must be replaced, since such distortion exceeds the elastic limit of the material causing fractures which may result in failure under ordinary operating conditions.

CAUTION: Do not attempt to straighten front axles with tubular style axle centers. Never apply heat to a front axle forging. Front axle should be straightened cold only.

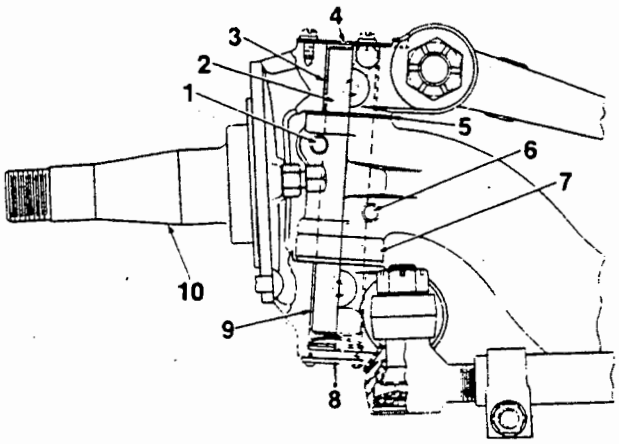
STEERING KNUCKLE

DESCRIPTION

Later MC-9 coaches have front axles with straight knuckle pins. The earlier MC-9 models have axles with tapered knuckle

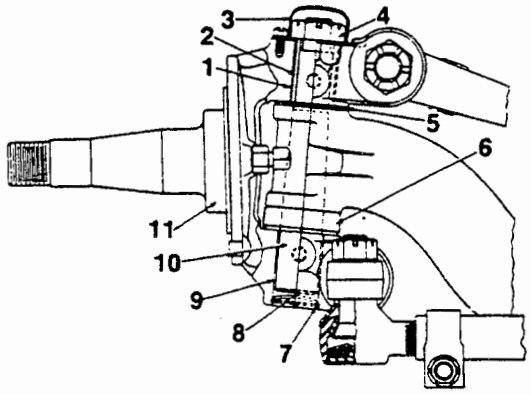
MC-9 MAINTENANCE MANUAL

pins. Figures 1-3 and 1-4 show the steering knuckle construction of the two different axles.



1. Draw Key - Upper
2. Knuckle Pin
3. Knuckle Bushing - Upper
4. King Pin Cap - Upper
5. Shims
6. Draw Key - Lower
7. Thrust Bearing
8. King Pin Cap - Lower
9. Knuckle Bushing - Lower
10. Knuckle/Spindle

Figure 1-3. Steering Knuckle (Later MC-9)



1. Knuckle Upper Bushing
2. Knuckle Pin Sleeve
3. Upper Dust Cap
4. Knuckle Pin Nut
5. Shims
6. Thrust Bearing
7. Expansion Plug Lock Ring
8. Expansion Plug
9. Knuckle Lower Bushing
10. Tapered Knuckle Pin
11. Knuckle/Spindle

Figure 1-4. Steering Knuckle (Earlier MC-9).

STEERING KNUCKLE REMOVAL

1. Block the rear wheels to prevent the vehicle from rolling. Jack up front of coach so that tires clear floor. Block up securely at this position and remove jacks. Refer to Section 3. Coach Jacking Points.

WARNING: Do not attempt to disassemble or perform knuckle repair with vehicle supported by jacks only.

2. Remove front wheels, hubs and bearings as directed in Section 15.

3. Remove brake chambers and brake shoe hardware from steering knuckle. Detach brake shoe spider from knuckle and remove spider, camshaft and slack adjuster as an assembly.

4. Remove drag link and tie rod from steering arm. Refer to Steering, Section 11.

5. Remove nuts from steering arms and drive arms out of steering knuckles.

NOTE: It is not necessary to remove steering arms unless service or inspection is necessary.

6. Upper and lower knuckle pin covers are present on the newer style axles with straight type knuckle pins. The original MC-9 axle, with the tapered knuckle pin, has a cover on the top of the pin only. Remove the capscrews from the cover(s) and the gasket(s) beneath the cover. See figure 1-5.

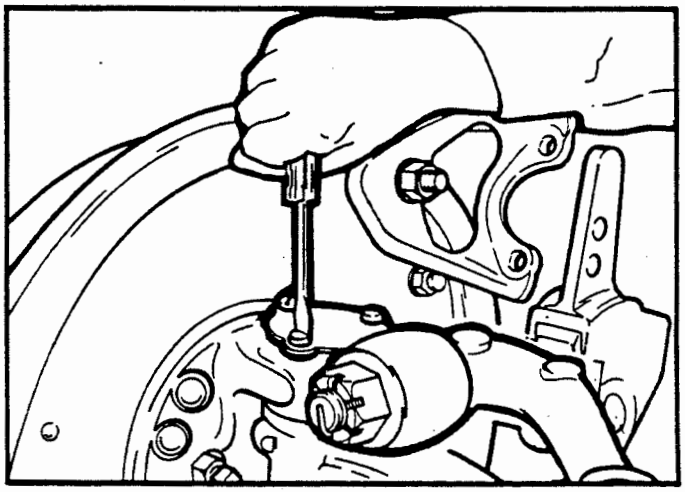


Figure 1-5. Removing Knuckle Pin Cover.

The tapered type knuckle pin has an expansion plug and lock ring at its lower end. Remove the lock ring with a pair of snap ring pliers. Dislodge and remove the expansion plug with a small drift.

7. The straight style knuckle pin is retained in the knuckle by means of threaded draw keys at the top and bottom of the knuckle. Remove the draw keys as follows:

a. Loosen locknut on key and turn it out to the end of the threads. The end of the nut should be flush with the draw key end.

b. With a brass drift and a hammer, firmly strike the end of the nut to loosen the draw key.

NOTE: Failure to strike the draw key squarely may result in a damaged key, causing removal difficulties.

c. Remove the nut and key from the axle center.

The tapered style knuckle pin is retained in the knuckle by a nut on the threaded upper end. Remove the knuckle pin cotter pin and nut. Refer to figure 1-6.

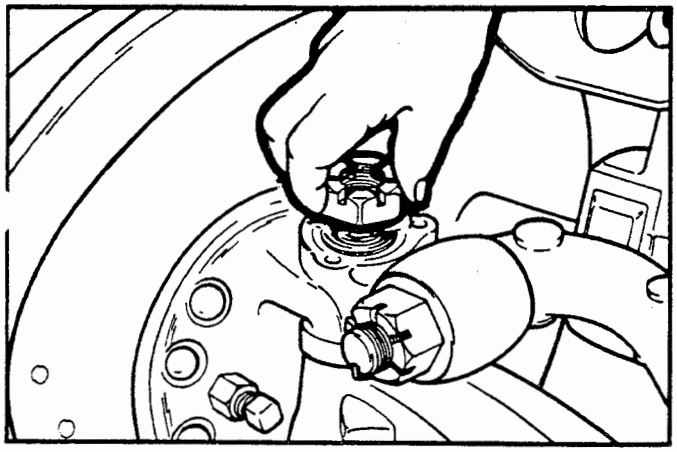


Figure 1-6. Removing Nut From Top of Tapered Knuckle Pin.

8. The knuckle pin, straight or tapered, is removed from the knuckle by tapping it out using a **bronze** drift. See figures 1-7 and 1-8.

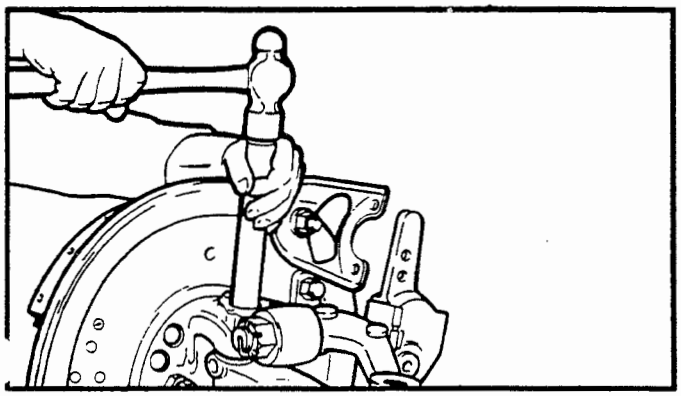


Figure 1-7. Removal of Straight Style Knuckle Pin.

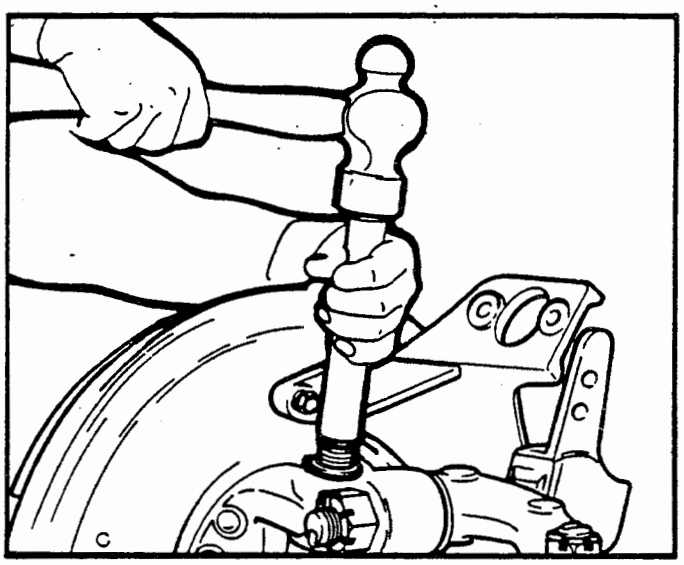


Figure 1-8. Removal of Tapered Style Knuckle Pin.

The following precautions and procedures will allow the pins to be removed with minimum danger of personal injury or damage to the knuckle pins and bushings.

a. Straight type knuckle pins may be removed through either the top or bottom of the knuckle. Tapered pins can only be removed through the bottom of the knuckle.

b. **Do not** strike the knuckle pin directly with a steel hammer. The pins are made of hardened steel. Personal injury can result from flying chips and splinters and, in the case of the tapered style pin, the threads on the upper end will be damaged.

c. If the bushings are not to be replaced, precautions must be taken not to damage them with the bronze drift. Grind off any flaring on the end of the drift which will contact the pin. Wrap tape around the drift 1/16" thick for the first inch from the end of the drift. This is especially important when the bushings are of the "Easy Steer" type used with the straight type knuckle pin.

9. If servicing the straight pin type knuckle, lift off the knuckle assembly, thrust bearing and shims. If servicing the tapered pin style knuckle, remove the knuckle pin sleeve, and lift off steering knuckle, thrust bearing, spacing washers, and backplate assembly. Refer to figure 1-9.

MC-9 MAINTENANCE MANUAL

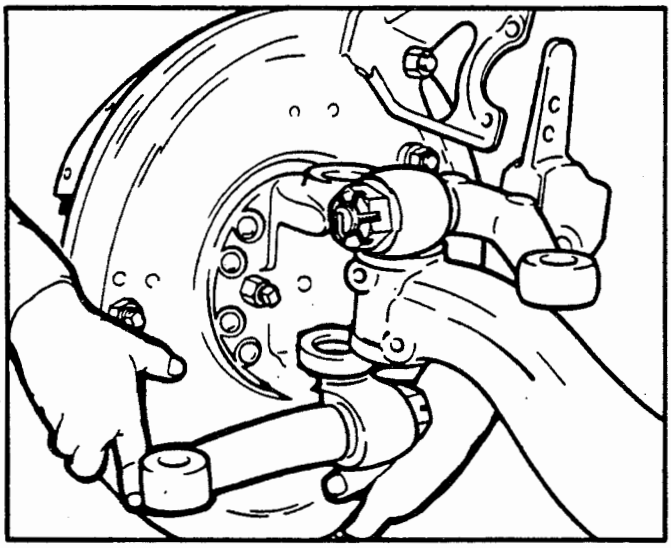


Figure 1-9. Removing Steering Knuckle From Axle.

STEERING KNUCKLE SEALS

Inspect the grease seals for tears, rips and deterioration. Do not remove the seals from the steering knuckle unless replacement is necessary or if the knuckle is to be rebushed. If seal is to be removed, pry it out with a screwdriver. Refer to figure 1-10.

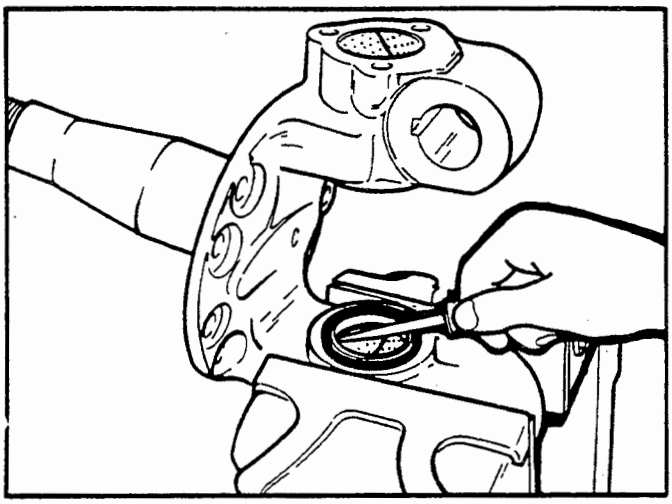


Figure 1-10. Grease Seal Removal.

If seal is being installed in a knuckle which has bronze bushings:

1. Place steering knuckle bottom side up in a vise equipped with soft metal protectors. Position upper knuckle boss (top end down) between jaws of vise and lock securely.

NOTE: Seals must be oriented as shown. Reversal of a seal will prevent purging of grease.

2. With the top end of the knuckle held firmly in this position, place the seal over the knuckle counterbore, with the rubber lip facing up.

3. Using a suitable sleeve and a bronze drift, tap the seal into the knuckle until it bottoms against the bushing or counterbore. See figure 1-11.

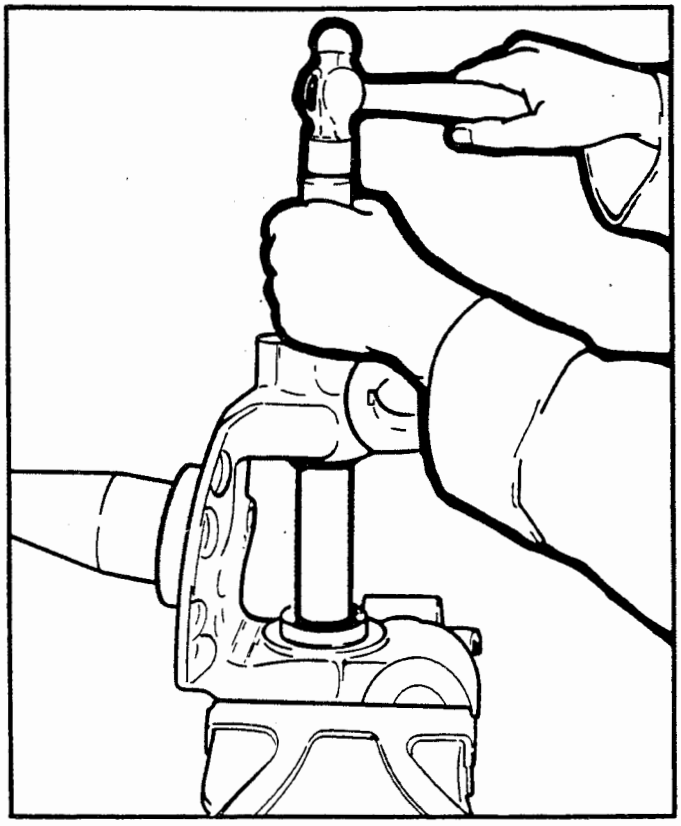


Figure 1-11. Installation of Grease Seal (Bronze or "Easy Steer" Bushed Knuckles).

MC-9 MAINTENANCE MANUAL

4. Repeat this procedure by reversing the knuckle for the lower seal.

NOTE: In the absence of a suitable driver, do not tap the seal in with a hammer. Set the seal in the opening and cover it with a rigid flat metal plate. Tap the plate with a hammer directly over the seal until the seal is flush with the machined surface. Do not drive the seal any further.

If the seal is installed in a knuckle which has "Easy Steer" bushings:

1. Follow instructions 1 and 2 for above bronze bushed knuckles.

2. Using a suitable sleeve and a bronze drift, tap the seal into the knuckle bore until it is flush with the machined surface as shown in figure 1-12.

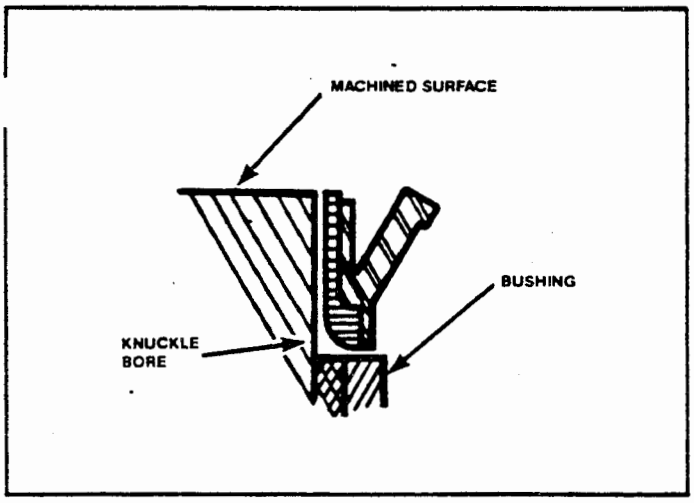


Figure 1-12. Grease Seal Installed in Knuckle With "Easy Steer" Bushings.

STEERING KNUCKLE BUSHINGS

The earlier MC-9 front axles have bronze steering knuckle bushings; the later MC-9 front axles have Rockwell "Easy Steer" bushings.

The tool shown in figure 1-13 should be used when removing or replacing the bushings. The tool shown in figure 1-14 should be used to size the bushings.

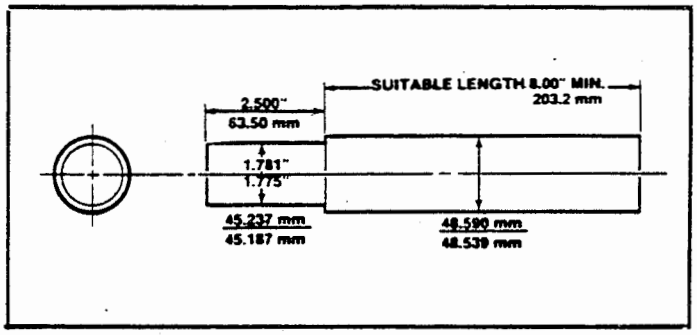


Figure 1-13. Tool - King Pin Bushing Removal & Installation.

These tools may be used with either type of bushing, but the diameter of the cutting surface of the reamer will vary, depending on whether the reamer is used on bronze or "Easy Steer" type bushings.

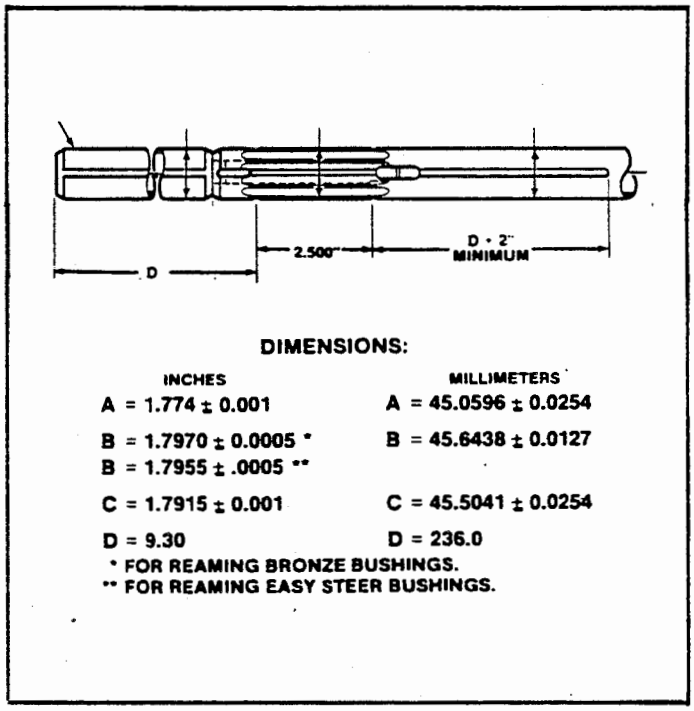


Figure 1-14. Reamer - King Pin Bushing.

The tools can be made from round steel bar stock. A reaming tool (part number 20-312) for the "Easy Steer" type bushings may also be purchased.

MC-9 MAINTENANCE MANUAL

STEERING KNUCKLE BUSHING REMOVAL AND INSTALLATION

The tool shown in figure 1-13 and a press of at least 5-ton capacity is required to remove or install the bronze bushings in the earlier MC-9 front axle knuckle, or to remove or install the "Easy Steer" bushings in the front axle knuckles of the later MC-9 models.

Before beginning the removal or installation of the bushings, fix the steering knuckle firmly on the bed of the press to avoid knuckle slippage during the bushing removal or installation.

To remove the bushings, insert the tool's pilot end into the bore of the bushing and press the bushing from the knuckle.

The procedure for installing the bushings will vary, depending on whether the bushing is of the bronze or "Easy Steer" type.

To install bronze bushings:

1. Align grease holes in bushing and in knuckle. The circumferential grease groove should be positioned toward the end of the king pin.

2. First press bushing into knuckle approximately ⅛", relieve press pressure and check alignment of tool and bushing.

3. The bushing can now be pressed in until it is .135" to .165" from the inside machined surface of the knuckle. This applies to both upper and lower bushings. **Do not install seals until after the reaming operation is complete.** Refer to figure 1-15.

4. Using the reamer shown in figure 1-14, finish the bushings to 1.7965-to-1.7975-inch diameter. The bushings must also be in line with each other to within .001 inch. Refer to the sizing procedure described later in this section.

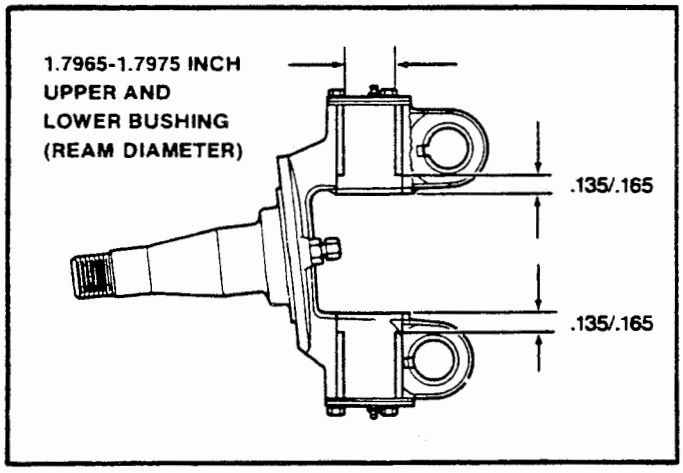


Figure 1-15. Bronze Bushing Installation.

To install "Easy Steer" bushings:

1. Press the upper bushing approximately ⅛" into the knuckle and relieve the press pressure. Check alignment of tool and bushing.

2. The bushing can now be pressed to the desired depth of 0.477 inch to 0.507 inch from the top of the machined surface. See figure 1-16.

3. Place the knuckle bottom side up and repeat step 1.

4. Press the lower bushing in to a depth of 0.412 to 0.442 inch from the bottom machined surface. See figure 1-16. **Do not install the grease seals until the reaming is completed.**

5. Using the reamer shown in figure 1-14, finish the bushings to 1.7950-to-1.7960-inch diameter. The bushings must also be in line with each other to within .001 inch. Refer to the sizing procedure described later in this section.

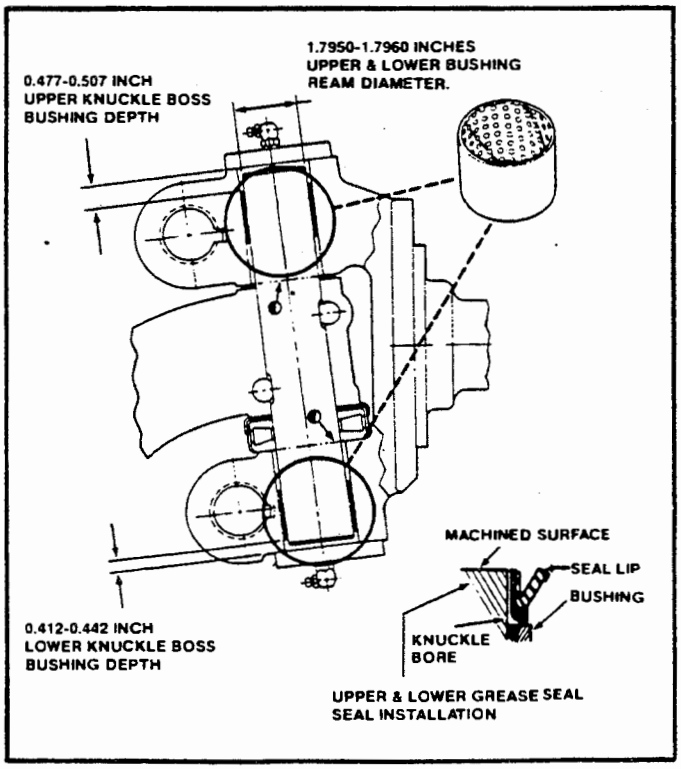


Figure 1-16. Easy Steer Bushing Instal'ation and Grease Seal Installation.

MC-9 MAINTENANCE MANUAL

SIZING NEW BUSHINGS

There are several methods of sizing the bushings but the only method which will give accurate size and alignment of the bore is reaming. Honing and burnishing do not provide good bushing bore alignment. Easy steer bushings are made of too resilient a material for them to be sized with a burnishing ball or bar.

The recommended procedure for reaming the bushings is as follows:

1. Position the knuckle in a vise with soft metal shims to protect the knuckle. It is preferable to have the king hole vertical.

2. Gently slide the reamer pilot through the upper bushing until the reamer cutters begin to engage the upper bushing. See figure 1-17.

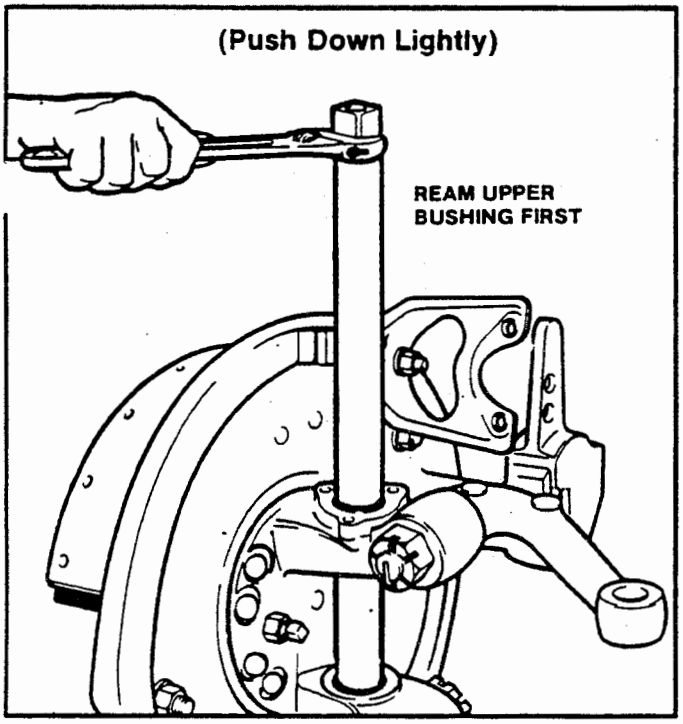


Figure 1-17. Size Upper Bushing.

3. Begin rotating the reamer and applying a light downward pressure with your hand at the same time. Do not force the reamer by applying too much downward force. The reamer can be rotated at any speed but should be done smoothly.

4. After the reamer sizes most of the upper bushing, support the reamer so that it does not drop to the bottom bushing as it completes the cut.

5. After the upper bushing has been sized, gently slide the reamer through until it engages the bottom bushing. See figure 1-18. Repeat steps 3 and 4 for the bottom bushing.

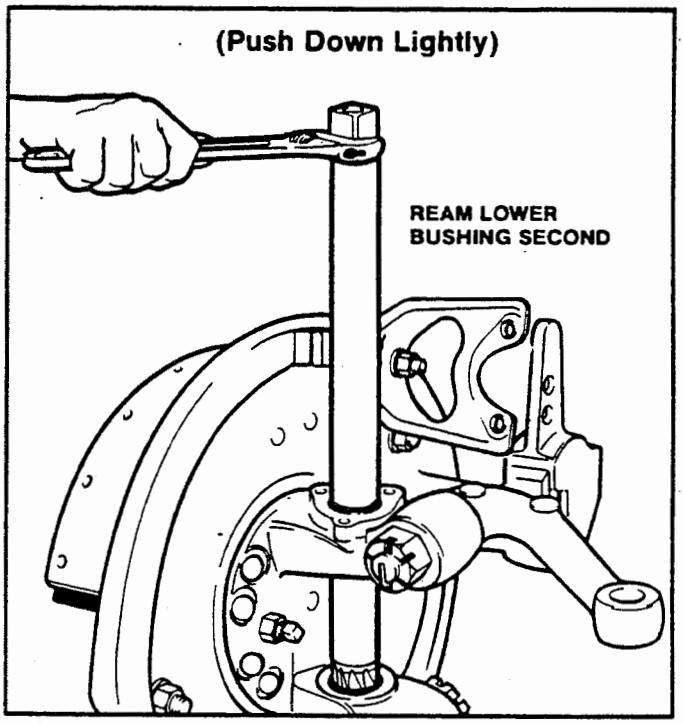


Figure 1-18. Sizing Lower Bushing.

6. Slide the reamer out through the bottom. If the reamer must be pulled back up through the bushing, do so only while rotating the reamer in reverse. Any other way will damage the bushings.

7. Clear bushing debris from bores before installing seals.

GREASE SEAL INSTALLATION

After the reaming operation is completed, install the grease seals. See the procedure as described earlier in this section.

MC-9 MAINTENANCE MANUAL

REASSEMBLY - AXLE CENTER TO STEERING KNUCKLE

THRUST BEARING INSTALLATION

The earlier MC-9 front axle does not have a seal at the thrust bearing under the steering knuckle. The later MC-9 front axles have a seal at the thrust bearing.

NOTE: Some of the thrust bearings used in front axles have the word "TOP" stamped on the flat face of the bearing retainer. The stamped word "TOP" should not be used for bearing installation purposes. Refer to the following instructions for proper bearing positioning.

Prior to putting the thrust bearing in the axle center-knuckle assembly, if the bearing has a seal, assemble the bearing and seal by holding the bearing so that the opening between the bearing cage and the retainer is up. Then snap the seal securely over the opening. See figure 1-19.

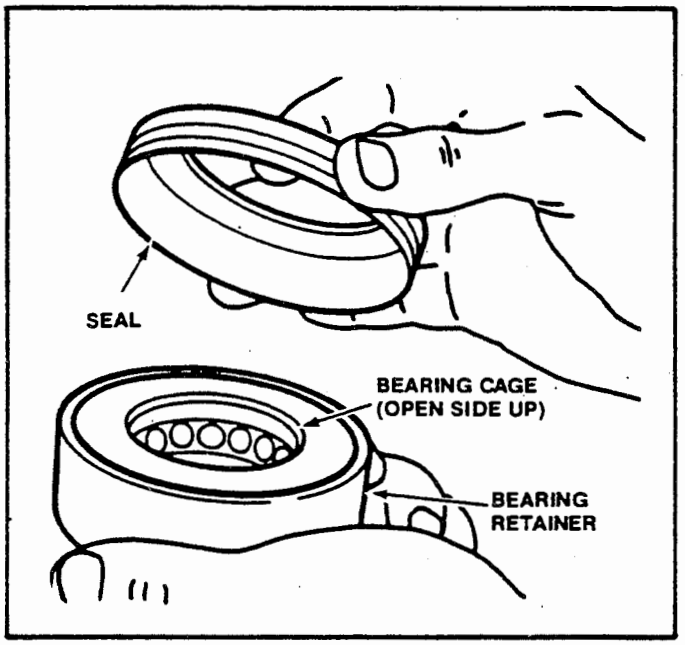


Figure 1-19. Bearing And Seal Assembly.

The assembly of the axle center and knuckle now proceeds as follows:

1. Position and support the steering knuckle assembly on the axle center.

2A. Thrust Bearings With Seals — With the seal positioned on top of the thrust bearing, slide the bearing and seal assembly between the lower face of the axle center and the upper face of the knuckle yoke. See figure 1-20.

NOTE: The thrust bearing must be seated on the upper face of the lower knuckle yoke. The seal must cover the opening between the bearing cage and retainer. Always install the bearing and seal assembly in the axle with the seal on top. See figure 1-20.

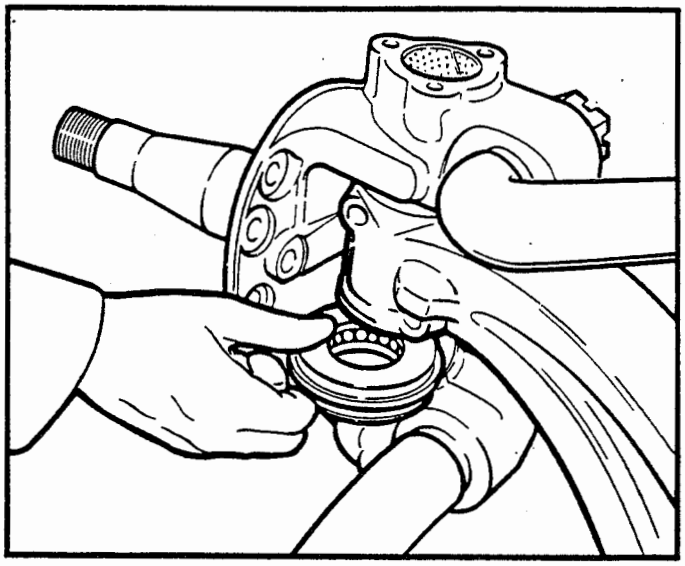


Figure 1-20. Installing Knuckle And Seal Assembly.

2B. Thrust Bearings Without Seals — With the open side of the thrust bearing facing down, slide the bearing between the lower face of the axle center and the upper face of the lower knuckle yoke. See figure 1-21.

NOTE: The thrust bearing must be seated on the face of the lower knuckle yoke. The bearing should always be installed in the axle with the closed retainer face up and the cage face (with the opening) down. See figure 1-21.

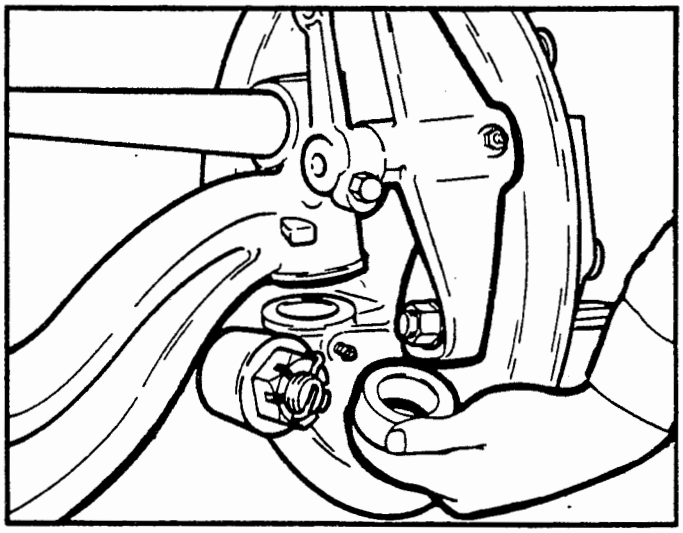


Figure 1-21. Installing Thrust Bearing (No Seal).

3. Shim the knuckle and axle assembly. Shims are positioned between the upper axle center face and the upper knuckle yoke. See figure 1-22. Shims are used to limit the vertical movement of the knuckle with respect to the axle center and king pin. Some clearance in this area is required, however, to allow grease to purge from the upper bushing area. Carefully inspect shims, new or used, to be sure none are kinked, bent or torn. Discard any that are damaged. Select a quantity of shims to obtain as little vertical end play as possible. Lift the knuckle in position and slide the shim pack between the axle center boss and the knuckle upper yoke.

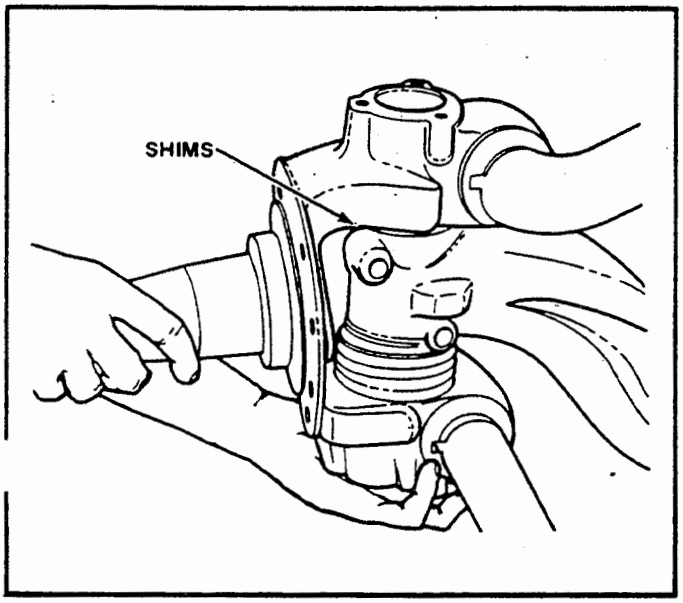


Figure 1-22. Shimming Axle And Knuckle.

Alignment of the king pin hole in the knuckle and axle center is now required for king pin installation. While looking down through the king pin hole, shift the knuckle to align it with the axle center. Now align the shims to be flush with the axle center around the entire circumference of the king pin hole. The shim alignment can only be done through the upper bushing. Any protrusion of any portion of the shim will prevent the king pin from passing through and result in a damaged shim.

NOTE: Shims are delicate and sharp. Extreme caution should be exercised while aligning shims so as not to cut fingers or bend the inside diameter of the shims. Damage to the shims during this entire procedure requires disassembly and replacement of the damaged parts.

4A. To install the straight type king pin:

a. Smear clear chassis grease on the bottom half of the king pin and insert it slowly into the top of the knuckle. King pins are marked with the Rockwell logo, part number and the word "up" on the top end of the pin. Rotate the pin to align the draw key slots with the draw key holes in the axle. Slowly push the pin through the bushing, seal and shim pack. The pin should slide through the shim pack freely. Any resistance greater than a hand push indicates misalignment. Remove the pin and realign the components. After the pin is inserted through the shim pack, a brass hammer may be used to assist in installation. Care must be taken not to dislodge the lower grease seal as the king pin enters the lower knuckle yoke.

b. Center the king pin in the knuckle to equalize the distance from the top and bottom surfaces. For knuckles with a bottom welsh plug arrangement, increase the bottom gap to allow for assembly of the welsh plug and snap ring.

c. Lightly tap the draw keys into position, flat side toward king pin; do not firmly seat them until after the end play measurement. Install the lower draw key from the front side and the upper draw key from the rear. Assemble so the wedged ends of the two keys contact the king pin and torque to restrict pin from moving while the end play is measured. The procedures for end play measurement and for seating the draw keys will be found later in this section.

NOTE: Never install both draw keys from the same side.

4B. To install the tapered type king pin:

a. Smear chassis grease on the tapered section of the pin and insert the pin from the bottom of the knuckle.

b. Smear chassis grease on the inside and outside of the king pin sleeve and insert it into the upper bushing bore over the king pin.

c. Install king pin nut, and torque only enough to seat the king pin for end play measurement.

d. Measure end play according to the procedure which is given later in this section and adjust if necessary.

e. Torque nut to 350-390 ft. lbs. (475-529 Nm) and install cotter key. If the cotter hole does not align with the nut castellation, advance the nut. Do not back the nut off.

5. Measurement of knuckle end play:

NOTE: A procedure for measuring end play with axle installed on coach and with wheels and tires installed can be found later in this section.

NOTE: The use of shim gauges (feeler gauges) for measurement of clearance tolerances on steering knuckles is not recommended. These will not give an accurate reading of end play. Use only a dial indicator.

NOTE: End play is the free movement of the steering knuckle up and down along the axis of the king pin. Some end play is required to prevent binding of the knuckle while turning and to provide a passage for grease to purge during bushing lubrication. Excessive end play can cause interference between the king pin and end caps or retainers.

MC-9 MAINTENANCE MANUAL

a. With king pin caps off, turn the knuckle to the straight ahead position. Take a rubber mallet and repeatedly strike the top draft of the knuckle as shown. This will shift all of the components down and remove grease layers so an accurate reading may be taken (figure 1-23).

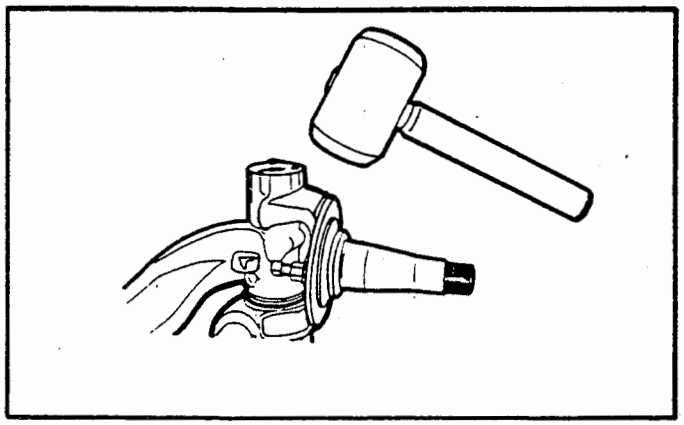


Figure 1-23. Striking Knuckle.

b. Attach the dial indicator with a "C" clamp or magnetic base to the knuckle spindle such that the knuckle can be turned freely as shown (figure 1-24).

c. Place the dial indicator plunger on the exposed end of the king pin so that its line of action is approximately parallel to the king pin center line (figure 1-24).

d. Zero the dial indicator.

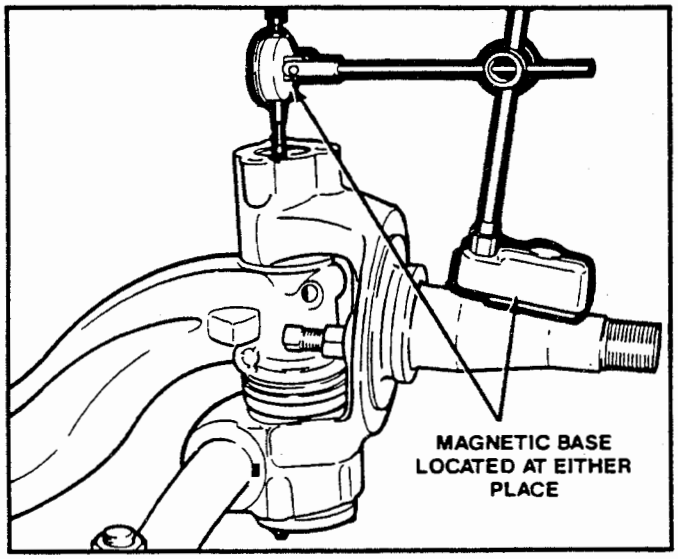


Figure 1-24. Dial Indicator Installation.

e. Measure the knuckle clearance (end play) by using a suitable lever to lift the knuckle while observing the dial indicator. Make a note of the measurement (figure 1-25).

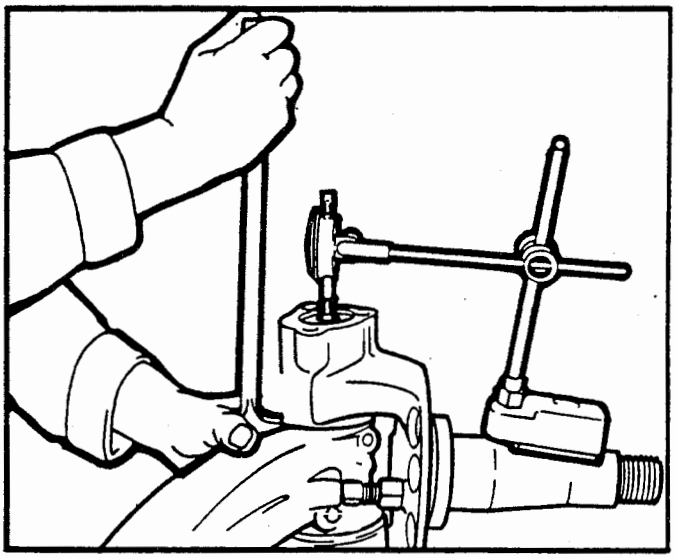


Figure 1-25. Measuring End Play.

A small hydraulic jack under a block of wood can be used beneath the knuckle to provide the necessary lift. Keep lifting the knuckle until the dial indicator reading levels off (figure 1-26).

CAUTION: When using a hydraulic jack, be sure that the axle is supported by two jack stands. Raising the end in this manner may cause an axle supported only in the center to tip and fall, causing personal injury.

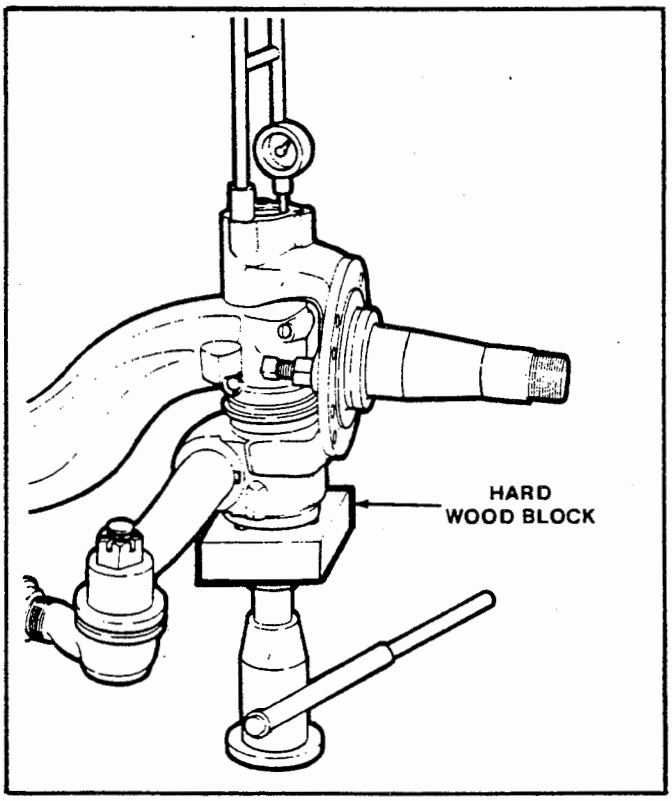


Figure 1-26. Lifting Knuckle With Jack.

f. Repeat steps *5a.* through *5e.* with the knuckle in the full right and left turn positions. This is necessary to be sure that no binding or excessive play is present during turns.

IMPORTANT: If binding exists or zero end play is measured anywhere in the full travel of the knuckle, remove shims as required to obtain end play of .001" to .025".

IMPORTANT: After measuring knuckle clearance (end play) of over .025", add shims between upper knuckle pin boss and axle center end, as required, to obtain an end play of .001"-.025" (.02-.64 mm) through full range of turn.

NOTE: Normal seating of the thrust bearing, seal and shims will increase the end play reading after a short time in service.

6. Seating Draw Keys — The knuckle pins on later MC-9 units are retained by draw keys. After the specified end play is obtained, seat the draw keys firmly with a hammer and drift (figure 1-27).

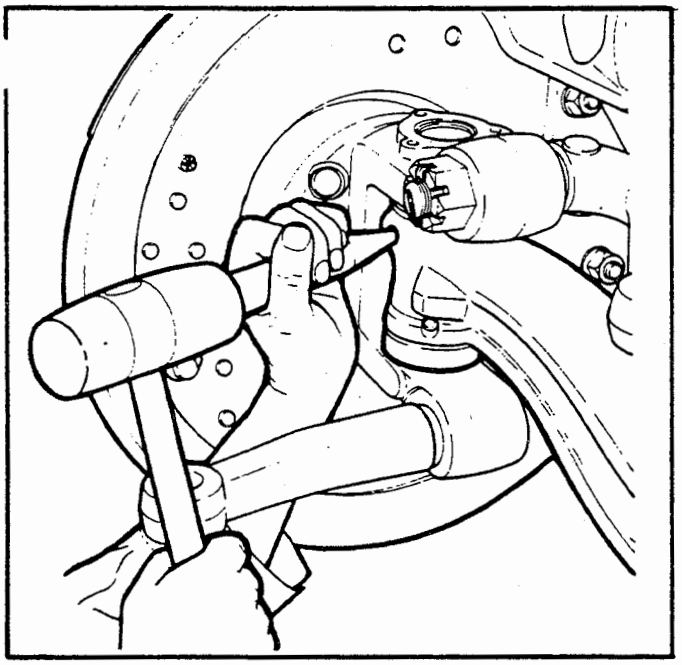


Figure 1-27. Seating Draw Keys.

IMPORTANT: Even though they are threaded, the keys must be solidly seated in this manner. The nut torque on the threaded design is only sufficient to hold the key in position and is not adequate to properly seat the key.

Install flanged locknut and torque to 30-40 lb. ft.

7. Securing Tapered King Pins — On earlier MC-9 coaches with drop forged axle centers (which have tapered king pins), the procedure for securing the pin is given in step 4B.

8. Installation of King Pin Caps and Welsh Plugs:

IMPORTANT: Before king pin caps and/or welsh plugs are installed, recheck draw keys and king pin nut to be sure the final staking or torqu-ing procedure has been completed. Omission of the final king pin securing steps may result in damaged or broken king pins and axle centers.

A. On the axles of later MC-9 coaches:

1) Align king pin caps and gaskets and assemble to knuckles with capscrews and washers.

2) Gaskets do not have a top or bottom orientation and may be installed in either position.

3) Caps do require orienting the flat side toward the gasket and knuckle. The flat, sealing side contains no numbering or lettering.

4) Torque fasteners to 20-30 lb. ft.

B. On the axles of earlier MC-9 coaches:

1) Place welsh plug into the lower knuckle bore with the rounded (convex) side toward the king pin.

2) Install lock ring.

9. Bushing Lubrication:

A. Grease upper bushing first, then the lower bushing. Use molybdenum disulfide grease. If grease does not flow through the thrust bearing, it will be necessary to raise the knuckle with a jack to close off passage of grease around the thrust bearing. Regrease the lower bushing and thrust bearing, then remove jack.

B. Rotate knuckle lock to lock to help distribute the grease. Note the knuckle will now be noticeably harder to rotate than during the end play measurement. This is normal.

C. Repeat step A.

D. On models using draw keys fill the voids in the draw key holes with grease to prevent corrosion and ease future disassembly.

10. The steering knuckle/axle center reassembly is now complete.

MC-9 MAINTENANCE MANUAL

MEASURING KNUCKLE END PLAY WITH AXLE, WHEELS AND TIRES INSTALLED

1. Securely block vehicle to prevent rolling.
2. Place a jack under the axle beam as close as possible to the knuckle end being checked and jack the vehicle up until the tire is clear of the floor.
3. Attach a dial indicator to the axle beam with a "C" clamp or magnetic base (figure 1-28).

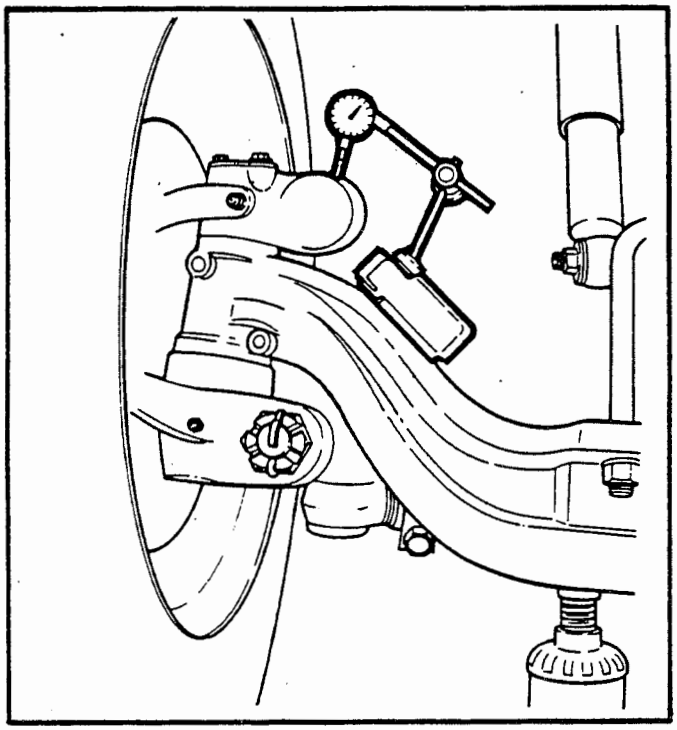


Figure 1-28. Dial Gauge Installed.

4. Place the dial indicator plunger on top of the king pin cap or knuckle forging so that its line of action is approximately parallel to the king pin center line.
5. Zero the dial indicator.
6. Measure the knuckle clearance (end play) by using a suitable lever to lift the knuckle while observing the dial indicator. Make a note of the measurement.

On axles in service, the end play may increase to a maximum of .065" (1.70 mm) at which time it will be necessary to re-shim end play back to .001"-.025" (.02-.64 mm).

NOTE: Both knuckles should be checked.

If a reading of over .065" is taken, remove the tire and king pin cap and remeasure as per rebuild procedure. If the reading is still over .065", then re-shim to specifications.

TIE ROD ENDS

The tie-rod assembly is of three-piece construction comprised of a rod and two end assemblies. See figures 1-29 and 1-30. The tie-rod end automatically compensates for wear on bearing surfaces. The tie-rod end stud is held in contact with the bearing surface by tension of a spring which holds the seat firmly against the inner end of the stud. An end plug, retained by a locking ring, holds the internal tie-rod end parts in position. Excessive play indicates that the bearing surfaces are worn, and new tie-rod end assemblies should be installed.

On some coaches non-repairable ends are used. These assemblies must be replaced as a complete unit.

Socket wear is indicated by ball stud turning torque and socket end movement. End movement may be checked with the socket assembly attached to its mating arm. If a force sufficient to overcome the spring pressure is applied to the end of the forging, the amount of movement is an indicator of wear. New socket assemblies should have an end movement of not more than .020 inches (.508 mm). Maximum allowable end movement on worn sockets is .090 inches (2.28 mm).

To check the turning torque value between the tie rod end assembly stud and the ball cavity, the socket must be removed from the vehicle. Minimum allowable torque value is 5 in. lbs. (.565 Nm).

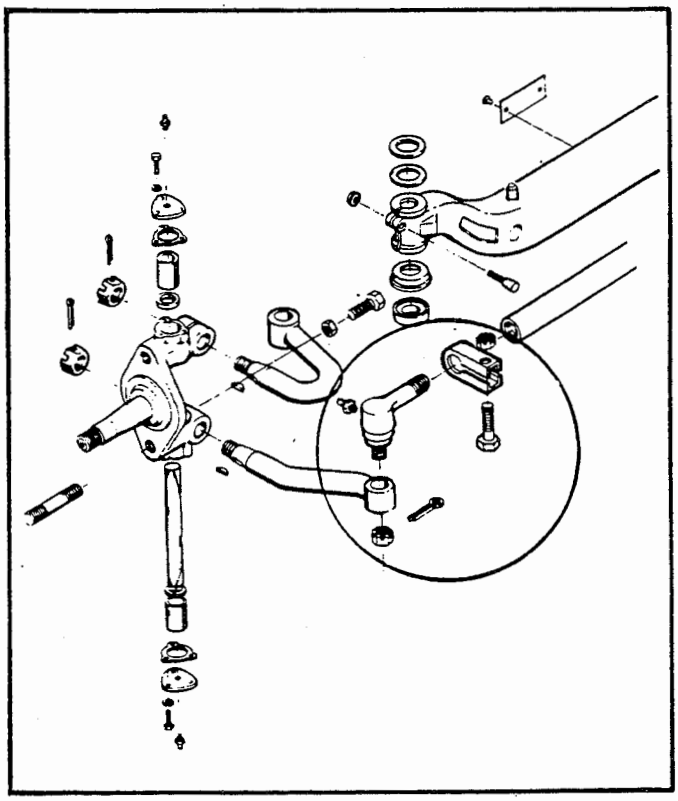


Figure 1-29. Tie Rod End (Later MC-9 Coaches).

MC-9 MAINTENANCE MANUAL

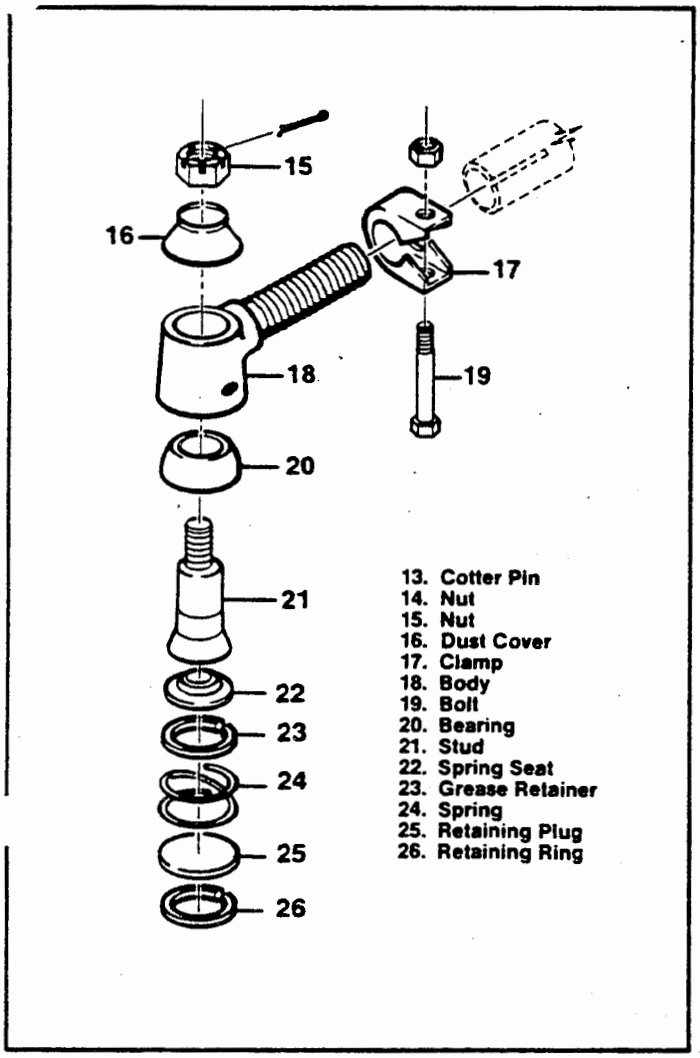


Figure 1-30. Tie Rod End (Earlier MC-9 Coaches).

REMOVAL

To remove tie-rod ends from the tie-rod assembly, remove cotter pins and nuts from the tie-rod ends, and support the steering arm to prevent bending. Using a small drift, rap the side of the tie-rod end to loosen it. Loosen clamp bolts and remove tie-rod ends from the tie-rod tube.

REPAIR (REPAIRABLE ENDS ONLY)

Pry end plug lock out of groove in body. Remove plug, seat, and spring. Remove grease retainer. Stud and bearing assembly can then be removed from the tie-rod end body.

All worn parts should be replaced. Tension of the retaining spring should be checked, and the spring replaced if it does not have sufficient tension to hold the tie-rod end stud firmly against the bearing. A new grease retainer should be used.

Lubricate parts with light grease before reassembly. Insert stud and bearing assembly into tie-rod end body, place grease retainer over end of end stud seat, and position seat in body. Place the retaining spring inside the seat, position end plug on spring, then compress spring and install end plug lock in groove.

Before replacement of tie-rod on steering arm, clean tapered portion of tie-rod end stud.

REASSEMBLY

Assemble the tie rod end on the tie rod tube, but do not tighten the clamp bolt. Insert the tie rod end stud into the steering arm and tighten to 165-180 lb. ft. torque (224-244 Nm). Tighten clamp bolts to 55-60 lb. ft. torque (75-88 Nm). When replacement of the tie rod assembly is required, the toe-in should be checked as described later in this section.

FRONT END ALIGNMENT

Correct front end alignment must be maintained for ease of steering and satisfactory tire life. Road shock, vibrations, normal stresses and strains set up in the front end system under average operation can result in loss of front end alignment.

If incorrect front end alignment is suspected, front wheel balance should first be checked to make sure that the difficulties are not originating from out-of-balance front wheels. A check of the inflation, wheel installation and runout, wheel bearing adjustment, tie rod and draglink end wear should also be made.

Correct front end alignment can only be maintained when parts in the steering knuckle are in satisfactory condition.

Factors in front end alignment are as follows:

A. Front wheel toe-in: The distance the wheels are closer together at the front than at the rear.

B. Front wheel camber: The amount the wheel inclines from the vertical plane. "Positive" camber means the wheels lean outward at the top. "Negative" camber means the wheels lean inward at the top, and "Zero" camber means that the wheels are in a vertical plane.

C. Axle caster: The fore and aft inclination from vertical of the steering knuckle. "Positive caster" is inclination of the top of the steering knuckle towards the rear of the vehicle. "Negative caster" is the inclination of the top of the steering knuckle towards the front of the vehicle. "Zero" caster means no inclination of the steering knuckle.

D. King pin inclination: The amount king pins are inclined inward at the top.

E. Steering geometry: The science of keeping the front wheels in proper alignment during left or right turns.

CAMBER

Wheel camber is the tilting of the front wheels from the vertical center line. Outward inclination at top provides positive camber and inward inclination provides negative camber.

Camber variations may be caused by wear at wheel bearings and steering knuckle bushings or by bent knuckle or sagging axle center.

Excessive positive camber results in irregular wear of tires at outer shoulders. Negative or reverse camber causes wear at inner shoulders. Ease of steering is also affected by any deviation from specified camber.

Position front wheels on turning plates in a straight ahead position. Attach alignment gauges to each wheel spindle. Record the camber readings for each wheel and compare with specifications. Refer to figure 1-32 and Front Axle Specifications Chart at the end of this section.

TOE-IN ADJUSTMENT

Wheel toe-in is the distance the front wheels are closer together at the front than at the rear of axle.

Incorrect toe-in results in excessive tire wear caused by side slippage. Unstable steering with a tendency to wander may also result. The following steps are to check and adjust toe-in:

NOTE: Make sure vehicle is on a level floor.

Do not measure toe-in with the front axle jacked up. The toe-in should be measured with the weight of the vehicle on the axle.

1. Jack up the front axle.

2. Use paint or chalk and whiten the center area of both front tires around the entire circumference.

3. Position a scribe or pointed instrument against the whitened part of each tire and rotate the tires. the scribe must be held firmly in place so that a single straight line is scribed all the way around the tire.

4. Place a full-floating turning radius gauge plate under each wheel. Lower the vehicle and remove the lock pins from the gauge plates. If full-floating turning radius gauge plates are not available, lower the vehicle and move it backward and then forward approximately 6 feet (1.8 m).

5. Position trammel bar at rear of tires and adjust pointers to line up with scribe lines and lock in place (scale should be set on zero). Pointers must be raised to spindle height on the tire as shown (figure 1-31).

6. Position the trammel bar at the front of the tires. Adjust scale end so that pointers line up with scribe marks.

7. Read toe-in or toe-out from the scale. Scale should read toe-in 1/16" ± 1/16" (1.58 mm ± 1.58 mm) (see figure 1-31).

8. If adjustment is necessary, loosen the tie-rod clamps and turn tie rod as required, then tighten the clamps. If the vehicle is not on gauge plates, move it backward, then forward about 6 feet (1.8 m).

9. Recheck the toe-in to ensure that it is correct.

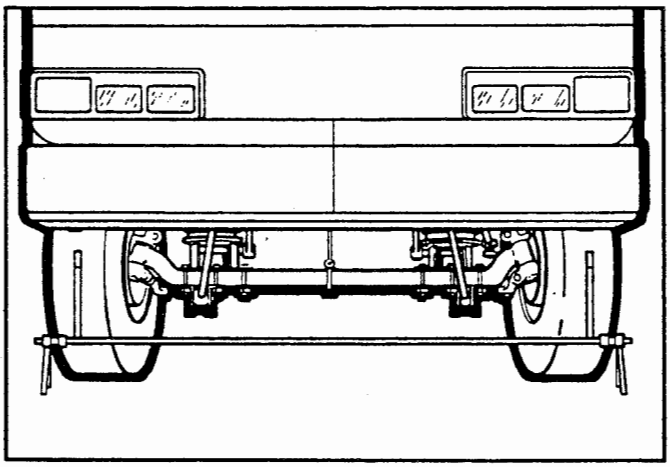
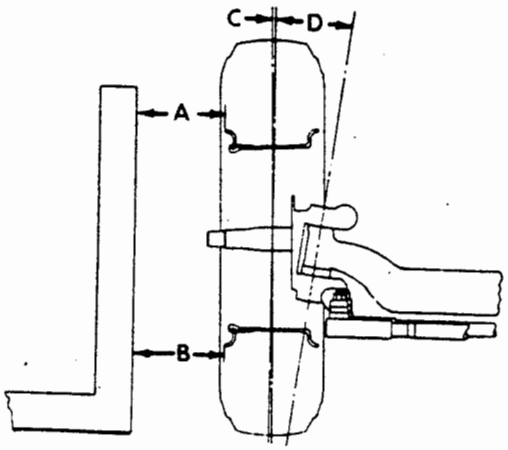
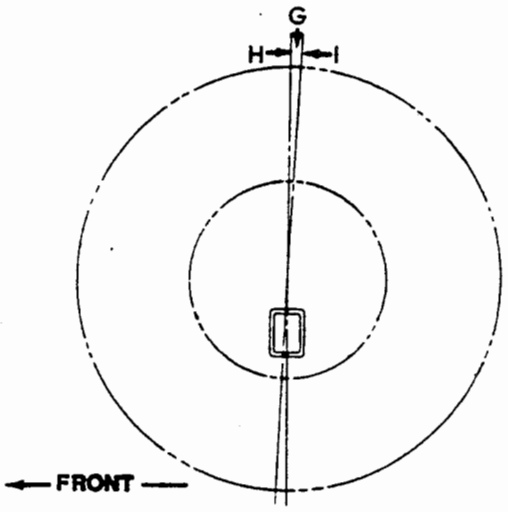


Figure 1-31. Trammel Bar With Pointers Set At Spindle Height.

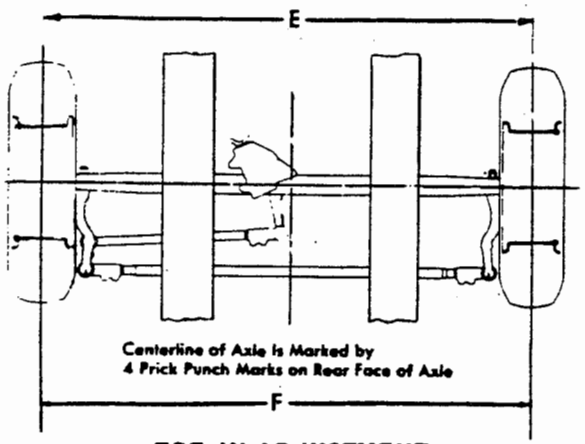
MC-9 MAINTENANCE MANUAL



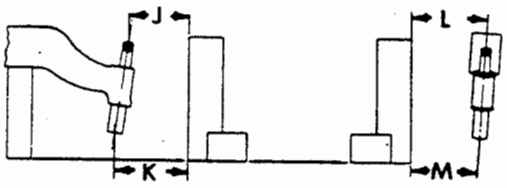
CAMBER & KING PIN INCLINATION



CASTER



TOE-IN ADJUSTMENT



KING PIN INCLINATION (BENCH CHECK)

CASTER

B Minus A ..... Camber (Inches)
C ..... Camber (Degrees)
D ..... King Pin Inclination(Degrees)
F Minus E ..... Front End Toe-In (Inches)
G ..... Caster (Degrees)
H ..... Vertical
I .....Centerline of King Pin
K Minus J ..... King Pin Inclination (Inches)
L Minus M .....Caster (Inches)
(Measure at Front of Axle)
Refer to "Front Axle Specifications" for numerical values.

Figure 1-32. Alignment Chart.

MC-9 MAINTENANCE MANUAL

TROUBLESHOOTING

1a. Rapid or Uneven Tire Wear
- Incorrect toe-in setting
- Improper tire inflation
- Unbalanced tires

b. Toe-in Control
- When setting toe-in, it is important to neutralize the component and tire deflections by backing up and then going forward and rechecking the toe-in. This is especially important with radial tires. The check and possible re-set should be followed even if bearing plates are used.

2. Hard Steering
- Low power steering system pressure
- Improper assembly or adjustment of steering gear box
- Inadequate or improper lubrication of knuckle pins
- Improper caster
- Tight draglink or tie rod ends
- Worn thrust bearing

3. Rapid Wear of Cross Tube Ends
- Inadequate or improper lubrication
- Severely contaminative environment
- Failure of protective dust cover.

4. Bent or Broken Cross Tube, Broken Ball Stud, Bent or Broken Steering Arm or Cross Tube Arm
- Excessive power steering system pressure
- Misadjusted power steering cut-off
- Operational (curbing)

5. Heavily Worn or Broken Steering Arm Ballstud
- Overtightened draglink
- Inadequate or improper lubrication

6. Excessive Wear of Knuckle Pins and Bushings
- Worn or missing seals and gaskets
- Improper type of grease
- Inadequate lubrication frequency
- Improper lubrication technique
- Inadequate lubrication frequency due to extreme operating conditions such as abrasive dust and sandy environments

7. Front Axle Shimmy or Vibration
- Incorrect master setting
- Wheels and/or tires not properly balanced
- Worn shock absorbers

MC-9 MAINTENANCE MANUAL

SPECIFICATIONS

FRONT AXLE SPECIFICATIONS

AXLE CENTER - EARLIER MC-9

Type	I Beam
Allowable Twist (Variation Between Ends)	½°

AXLE CENTER - LATER MC-9

Type	Tubular
Allowable Twist (Variation Between Ends)	½°

STEERING KNUCKLES - EARLIER MC-9

Spindle Diameter: Inner Bearing	2.562-2.561 in. (65.082-65.057 mm)
Outer Bearing	2.125-2.124 in. (53.970-53.957 mm)
Up-And-Down Movement	.005-.065 in. (.127-1.65 mm)
Bushing Bore Diameter	1.919-1.921 in. (48.743-48.793 mm)

STEERING KNUCKLES - LATER MC-9

Spindle Diameter: Inner Bearing	2.625-2.624 in. (66.662-66.637 mm)
Outer Bearing	2.125-2.124 in. (53.962-53.936 mm)
Up-And-Down Movement	.005-.065 in. (.127-1.65 mm)
Bushing Bore Diameter	1.919-1.921 in. (48.743-48.793 mm

STEERING KNUCKLE BUSHINGS - EARLIER MC-9

Material	Bronze
Inside-Line Ream	1.794-1.795 in. (45.555-45.580 mm)
Line Burnish	1.797-1.798 in. (45.631-45.657 mm)

STEERING KNUCKLE BUSHINGS - LATER MC-9

Material	"Easy Steer"
Ream Diameter	1.796-1.795 in. (45.618-45.593 mm)

KING PIN - EARLIER MC-9

Type	Tapered
Diameter - Large End	1.794-1.793 in. (45.568-45.542 mm)
Small End	1.310-1.309 in. (33.261-33.236 mm)

KING PIN - LATER MC-9

Type	Straight
Diameter	1.794-1.793 in. (45.568-45.542 mm)

FRONT WHEEL ALIGNMENT - LATER MC-9

Camber (B minus A)	¼° ± ⅜° (Curbside)
	¾° ± ⅜° (Roadside)
Caster Angle (G)	4.5°-5.0° Pos
Toe-In (E minus F)	0-1/16 in. (0-1.588 mm)
King Pin Inclination (D)	6°15' (Curbside)
	5°45' (Roadside)
Track: 102" Wide Models	85.7 in. (2.177 mm)
96" Wide Models	79.7 in. (2.024 mm)

MC-9 MAINTENANCE MANUAL

SPECIFICATIONS

FRONT AXLE SPECIFICATIONS

FRONT WHEEL ALIGNMENT - EARLIER MC-9

Camber (B minus A)	¼° ± ⅜° Neg (Curbside)
	¾° ± ⅜° Pos (Roadside)
Caster Angle (G)	2.5° ± 1° Pos
Toe-In (E minus F)	0-1/16 in. (0-1.588 mm)
King Pin Inclination (D), Right	6.25°
Left	5.75°
Track	79.7 in. (2,024 mm)

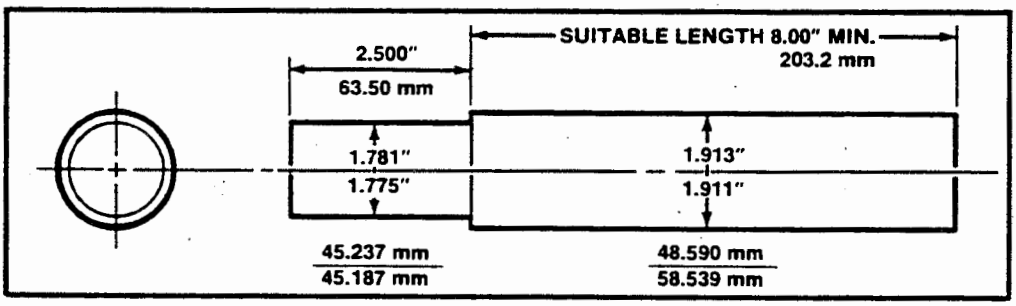
TORQUE SPECIFICATIONS

King Pin Nuts	350-390 ft. lbs. (475-529 Nm)
Tie Rod End Clamp Bolt Nuts	55-65 ft. lbs. (75-88 Nm)
Tie Rod End Steel Nuts	165-180 ft. lbs. (224-244 Nm)
Steering Arm Nuts	350-390 ft. lbs. (475-529 Nm)
Radius Rod Retainer Bolt Nuts	300-330 ft. lbs. (408-449 Nm)

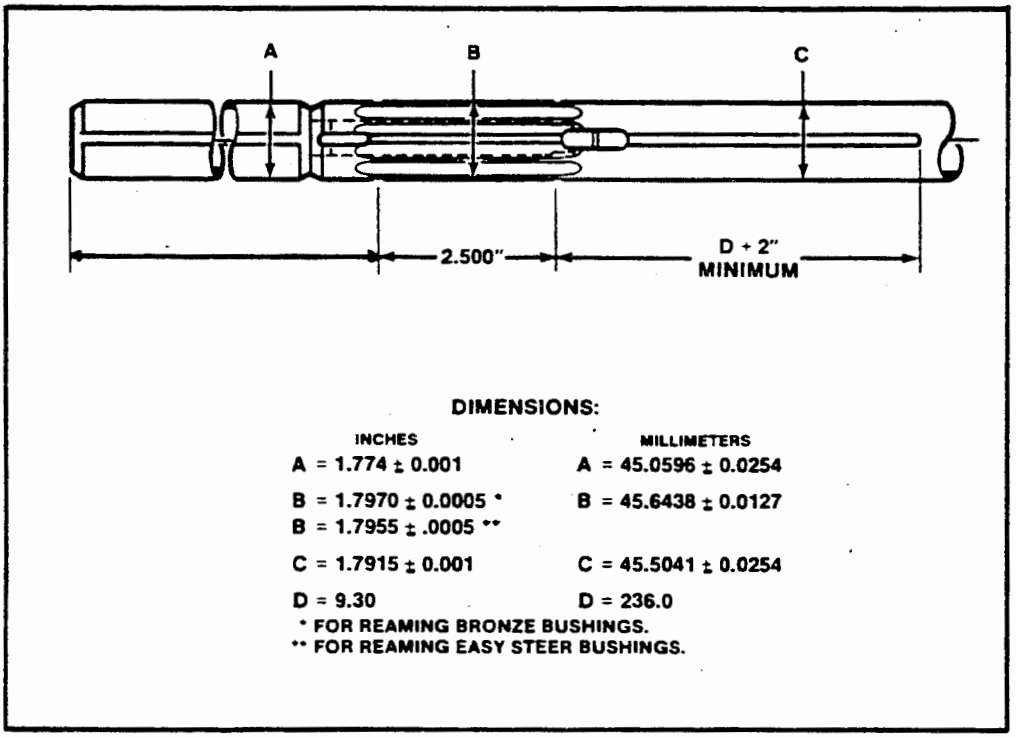
MC-9 MAINTENANCE MANUAL

SERVICE TOOLS

SOME OF THE TOOLS USED FOR THE MAINTENANCE PROCEDURES OUTLINED IN THIS SECTION ARE NONSTANDARD. THEY ARE, HOWEVER, AVAILABLE FOR PURCHASE FROM MOTOR COACH INDUSTRIES, TRANSPORTATION MANUFACTURING CORPORATION AND UNIVERSAL COACH PARTS. WHERE PRACTICAL, THEY MAY BE FABRICATED AT THE SERVICE FACILITY.



20-5 Tool - King Pin Bushing Removal & Installation



20-6 King Pin Bronze Bushing Reamer

20-312 King Pin "Easy Street" Bushing Reamer.

Date 1-1-89

MC-9 MAINTENANCE MANUAL

SECTION 2

REAR AXLES

SUBJECT	PAGE
Differential Carrier	2-5
Adjusting Preload of Differential Bearings	2-28
Adjusting Preload of Pinion Bearings	2-18
Adjusting Ring Gear Backlash	2-29
Adjusting Thickness of Shim Pack	2-22
Carrier Assembly Installation	2-33
Carrier Assembly Removal	2-6
Checking Ring Gear Runout	2-28
Checking Tooth Contact Patterns of Gear Set	2-30
Differential and Ring Gear Assembly	2-24
Differential and Ring Gear Disassembly	2-8
Differential and Ring Gear Installation	2-27
Differential and Ring Gear Removal	2-7
Drive Pinion, Bearing and Cage Assembly	2-17
Drive Pinion, Bearing and Cage Disassembly	2-11
Drive Pinion/Bearing Cage and Shim Pack Installation	2-21
Drive Pinion/Bearing Cage Removal	2-9
Matching of Ring Gear and Pinion Set	2-16
Reassembly of Differential - General Procedures	2-12
Yoke or Flange Installation	2-17
Drive Axle	2-1
Housing Repair	2-14
Load Tube Replacement	2-37
Lubrication	2-1
Maintenance	2-2
Removal	2-4
Torque Specifications	2-36
Specifications	2-39
Trailing Axle	2-38
Service Tools	2-40
Service Bulletin Page	

MC-9 MAINTENANCE MANUAL

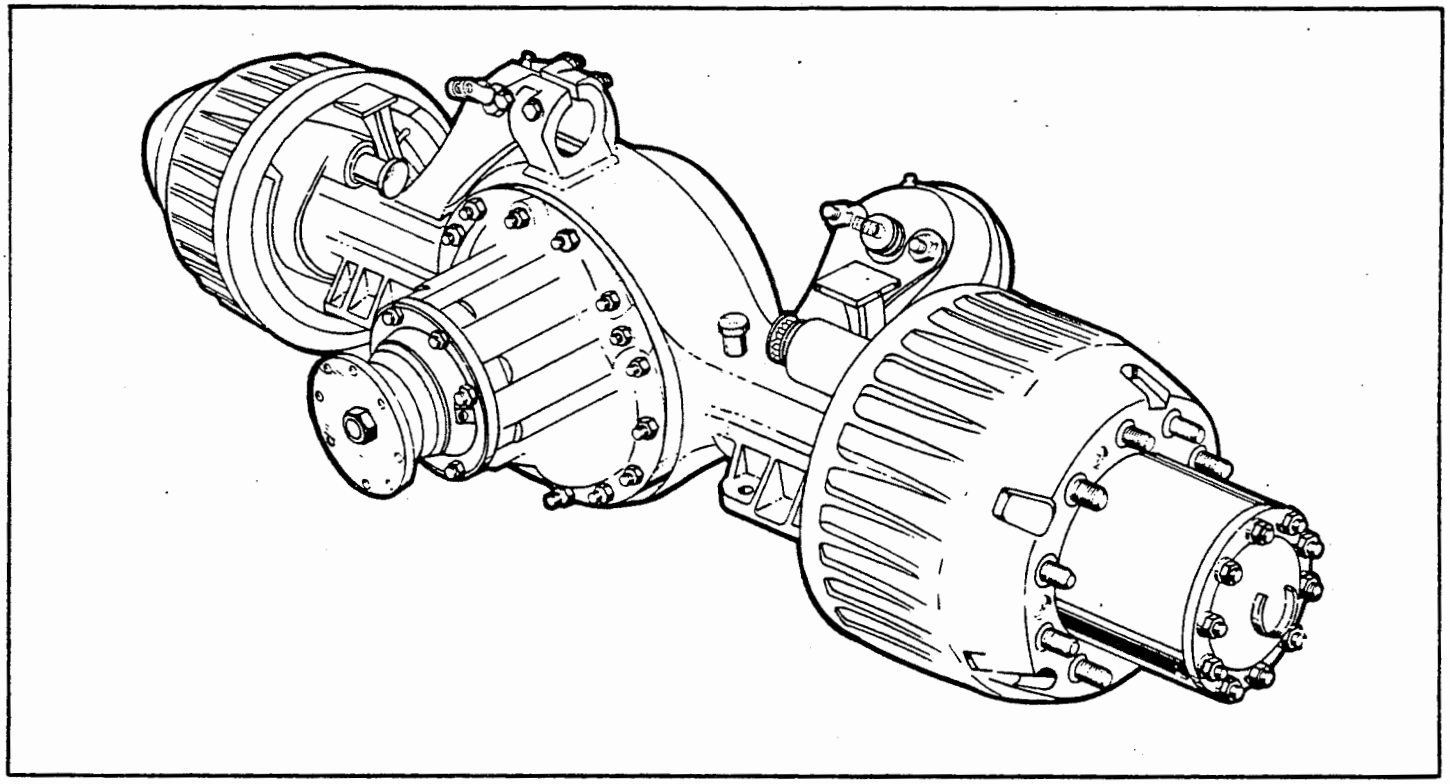


Figure 2-1. Drive Axle

REAR AXLES

DRIVE AXLE

The drive axle (figure 2-1) is a Rockwell Standard full floating type with pressed steel housing, fitted with replaceable pressed in steel sleeves. A magnetic drain plug is installed in the bottom of the housing.

The single reduction final drive employs a heavy duty hypoid drive pinion and ring gear. The differential and gear assembly is mounted on tapered roller bearings and lubricated by the differential oil.

The straddle-mounted pinion has two tapered roller bearings in front of the pinion teeth which take the forward and reverse thrust, and a third bearing behind the pinion teeth to carry the radial load.

The standard drive axle ratio on all of the coach models is 3.73:1. Optional ratios which may be present are 3.33:1 and 4.10:1.

LUBRICATION

Lubrication recommendations will be found in Section 10 of this manual.

During initial stages of normal operation, tiny metal particles are freed from mating surfaces of moving parts. These metal particles are carried by the lubricant through the assembly and act as lapping compound which accelerates wear of all parts.

To ensure maximum life of the differential and prevent premature failure, the original "factory fill" lubricant should be drained. This also prevents lubricant contamination caused by differences in the "factory fill" and lubricant used by the operator when topping up.

CAUTION: Change break-in oil after 1,000 miles (1,600 km) but no later than 3,000 miles (4,800 km). Drain the unit while still warm from operation.

See figure 2-2 for fill and drain plugs. Magnetic drain plugs perform the vital function of trapping small metallic particles that circulate in the lubricant, through the gears and bearings. They prevent rapid wear and premature failure. The magnet must be strong enough to firmly hold the particles under service conditions. We recommend plugs with elements having a minimum pick-up capacity of 2 pounds of low carbon steel in plate or flat bar form.

MC-9 MAINTENANCE MANUAL

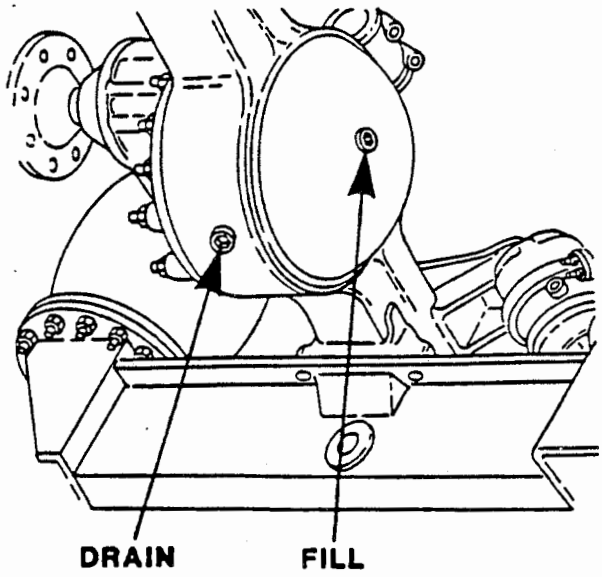


Figure 2-2. Drive Axle Housing.

Clean all magnetic drain plugs prior to reinstallation.

1. Fill axle housing to the correct level with specified lubricant with the vehicles on level ground. Use general purpose gear lubricant SAE 90 above 0°F. (-18°C.) or SAE 140 below 0°F. (-18°C.).
2. Lubricate universal joint.
3. Drive the vehicle, unloaded, for one to two miles at speeds not to exceed 25 miles per hour to thoroughly circulate the lubricant throughout the assembly.

For reconditioned axles, follow the same procedures as above, after overhaul.

OIL CHANGE INTERVALS

Gear oil should be changed every 25,000-30,000 miles (40,000-48,000 km) on units run over 60,000 miles (96,000 km) annually.

For units run less than 60,000 miles, the oil should be changed twice yearly (spring and fall) regardless of mileage.

The Rockwell axle drive unit employs the gravity feed (splash) system of distributing lubricant throughout the assembly. As the vehicle is initially driven in service, a short period of time is required for the lubricant to reach all areas of the drive units.

MAINTENANCE

Careful adherence to maintenance and lubrication procedures will go a long way toward successful operation.

The most common causes of drive axle carrier failures are spinout, shock, fatigue and poor lubrication.

Spinout is defined as excessive differential action. On a single rear axle, main differential spinout occurs when one wheel remains stationary while the other wheel is spinning. The relatively high speed differences between the mating parts generate heat, and the rate of heat generation increases with the speed differences. When the heat becomes excessive it can cause galling of the journals of the cross and the mating differential pinion bores. In extreme cases of spinout, enough heat may be generated to weld the differential pinion to the cross and cause a catastrophic failure.

Shock is another common cause of carrier failure. It results from a rapidly applied load or force that is severe enough to exceed the strength of the carrier component and cause it to crack or fail instantly.

There are a number of operating conditions which can result in a shock failure:

A. Hitting dry pavement with a spinning wheel.
B. Missing a shift.
C. "Popping" the clutch.
D. Reverse interlock failure.

If the failed part separates into two or more pieces, the operator will usually realize the fact immediately. But if the part is only cracked, the operator may not be aware of the damage until sometime later. Depending on the severity of the crack in the part, the final failure may not occur until many miles later. the crack will be a point of origin for a fatigue failure, and can progress until the part fails. Thus the failure could happen while the vehicle is being operated under normal conditions.

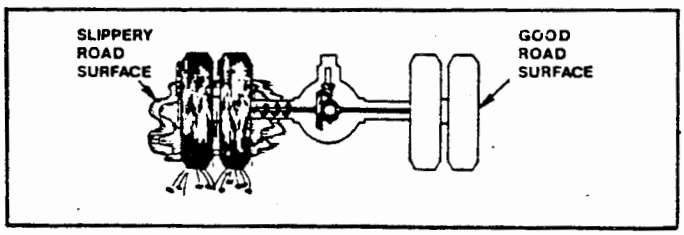
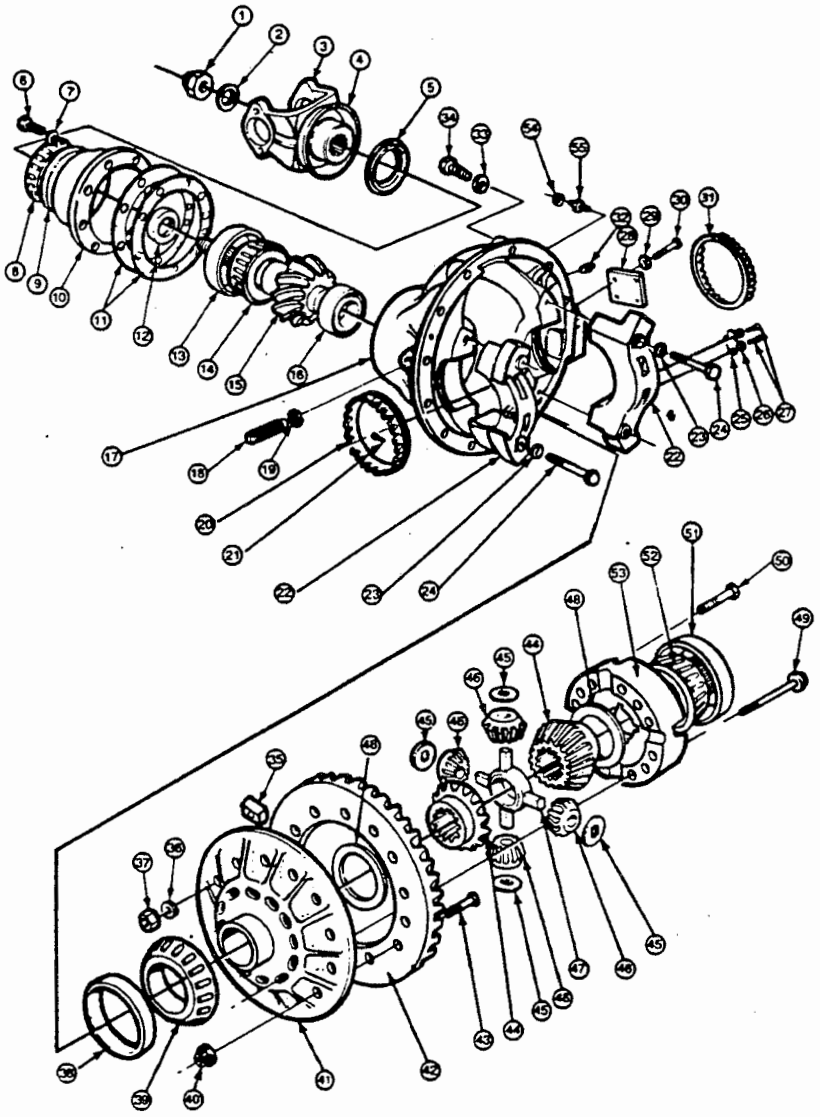


Figure 2-3. Drive Axle Spinout.

MC-9 MAINTENANCE MANUAL



1. Nut - Drive Pinion
2. Washer - Drive Pinion
3. Input Yokr or Flange
4. Deflector
5. Oil Seal
6. Capscrew - Bearing Cage
7. Washer
8. Bearing Cone - Pinion Outer
9. Bearing Cup - Pinion Outer
10. Bearing Cage - Drive Pinion
11. Shims
12. Spacer - Pinion Bearing
13. Bearing Cup - Pinion Inner
14. Bearing Cone - Pinion Inner
15. Drive Pinion
16. Spigot Bearing
17. Carrier
18. Thrust Screw
19. Jam Nut - Thrust Screw
20. Adjusting Ring - LH
21. Cotter or Pin
22. Caps - Differential Bearing
23. Washers
24. Capscrews - Differential Bearing Cap
25. Lock Plate - Adjusting Ring
26. Washers - Lock Plate
27. Capscrews - Lock Plate
28. Cover - Air Cylinder Opening
29. Washers - Cover
30. Capscrews - Cover
31. Adjusting Ring - RH
32. Plug - Oil Fill Hole (Carrier)
33. Washer - Capscrew Plug
34. Capscrew Plug - Sensor Hole
35. Thrust Block
36. Washers - Differential Case
37. Nuts - Differential Case
38. Bearing Cup - Differential LH
39. Bearing Cone - Differential LH
40. Nuts - Ring Gear & Case Half
41. Case Half - Flange
42. Ring Gear
43. Bolts or Rivets - Ring Gear & Case Half
44. Side Gears - Differential
45. Thrust Washeers - Differential Pinion
46. Pinions - Differential
47. Spider - Differential
48. Thrust Washers - Differential Side Gear
49. Capscrews - Differential Case
50. Bolts - Differential Case
51. Bearing Cup - Differential RH
52. Bearing Cone - Differential RH
53. Case Half - Plain

Figure 2-4. Single Reduction Differential Carrier.

Fatigue is another type of failure in axle carriers, one that results from repeated loadings of a component. A single application of these loads or forces is not great enough to damage the part but repeated applications gradually weaken it to the point of failure. Fatigue failures that occur in drive axle carriers have two sources:

1. Exceeding the GVW/GCW rating of the carrier
2. Shock loads

When the vehicle is operated at a weight in excess of what the carrier was designed for, the life of the components is reduced. The rated GVW/GCW of a carrier changes with the ad grade and surface. As the grade increases, so does the effort (torque) required to move a vehicle loaded to a given GVW/GCW. Again, as the road surface changes from hard to soft, rolling resistance increases and more torque is needed. Thus, a vehicle loaded to a given GVW/GCW will have a reduced carrier life when operated in hilly or mountainous terrain as opposed to being operated on the level. The same is true for operation on soft or unimproved surfaces as compared to hard surface roads.

The fourth common cause of axle carrier failures originates with the lubricant, or with lubricant change practices. The lubricant which protects the axle components has three key functions:

A. To reduce friction between parts.

B. To carry heat away from parts.

C. To carry dirt and wear particles away from parts.

When lubricant failure occurs, it is generally the result of improper maintenance and has its roots in one of three basic problem areas:

A. Low lubricant level.

B. Improper type of lubricant or lubricant with depleted additives.

C. Contaminated lubricant.

DRIVE AXLE REMOVAL

Removal of the entire axle is recommended to facilitate repair work on the carrier. Axle removal and replacement instructions follow.

Block front wheels of the coach to prevent rolling. Raise the rear end of the vehicle with jacks until the bottom of the body is approximately 18" (457.2 mm) from the floor. Block the body in this position as outlined in Section 3 under Coach Jacking Points.

CAUTION: Do not allow the rear axle assembly to hang on the air springs. Damage to the air springs may result.

1. Exhaust air pressure from the suspension system air tank by opening the drain cock on the bottom of air filter.

2. Disconnect the sway bar links.

3. Disconnect the brake chamber hoses.

4. Disconnect the driveline universal joint from the pinion input yoke or flange on the carrier (figure 2-5).

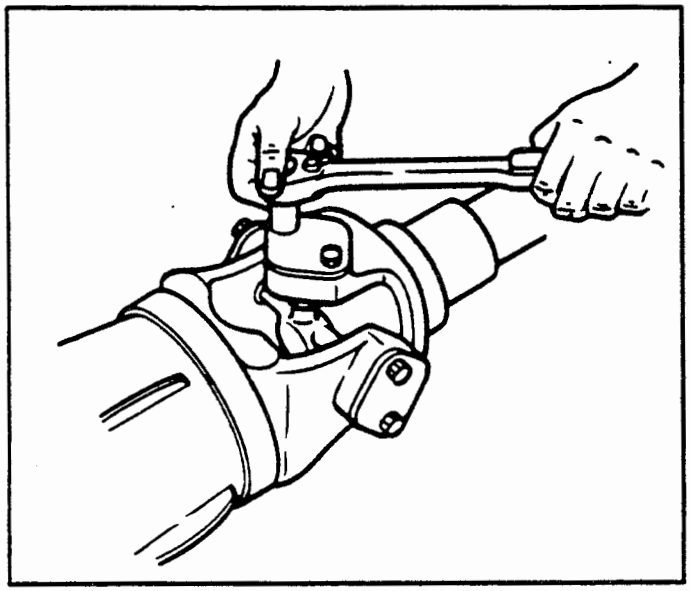


Figure 2-5. Disconnecting Universal Joint.

5. Disconnect both height control valve links from brackets, and pull down on each height control valve arm to exhaust air from the air springs.

6. Disconnect both ends of all four radius rods as outlined in this section under Radius Rods.

7. Remove shock absorbers.

8. Disconnect air springs from the suspension supports.

9. Lower the axle and carefully remove from under the coach body.

Replacement is the reverse of removal.

SINGLE REDUCTION DIFFERENTIAL CARRIER

DESCRIPTION

The single reduction differential carrier (Figure 2-6) is front mounted into the axle housing. This carrier has a hypoid drive pinion and ring gear set and bevel gears in the differential assembly.

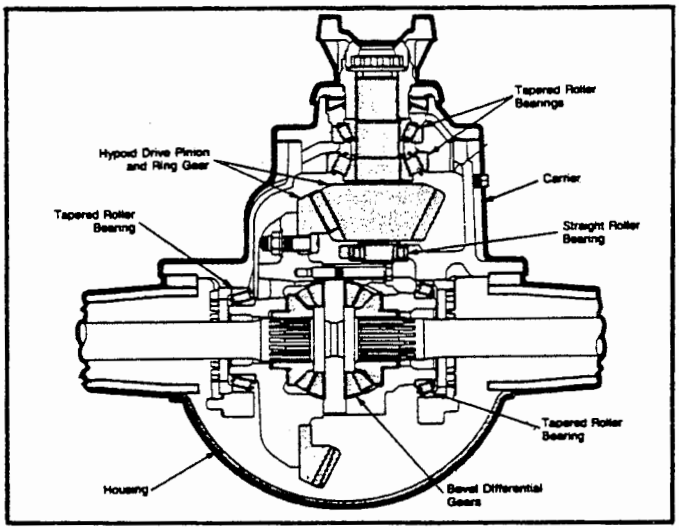


Figure 2-6. Single Reduction Differential Carrier.

A straight roller bearing (spigot) is mounted on the head of the drive pinion. All other bearings in the carrier are tapered roller bearings.

When the carrier operates, there is normal differential action between the wheels all the time.

REMOVAL OF CARRIER ASSEMBLY FROM AXLE HOUSING

1. After the axle has been removed from the coach, support it securely under the axle shaft housings. Support the axle at a height sufficient to allow a roller jack to pass under the center (banjo) of the axle.

2. Remove the plug from bottom of axle housing and drain lubricant from the assembly.

3. Remove the stud nuts and washers from the flanges of both axle shafts.

4. Loosen the tapered dowels in the flanges of both axle shafts as follows.

WARNING: Wear safe eye protection. Do not hit the round driving lugs on the head of axle shafts. Lugs can break and cause injury.

a. Hold a 1½-inch-diameter brass drift against the center of the axle shaft, inside the round driving lugs (Figure 2-7).

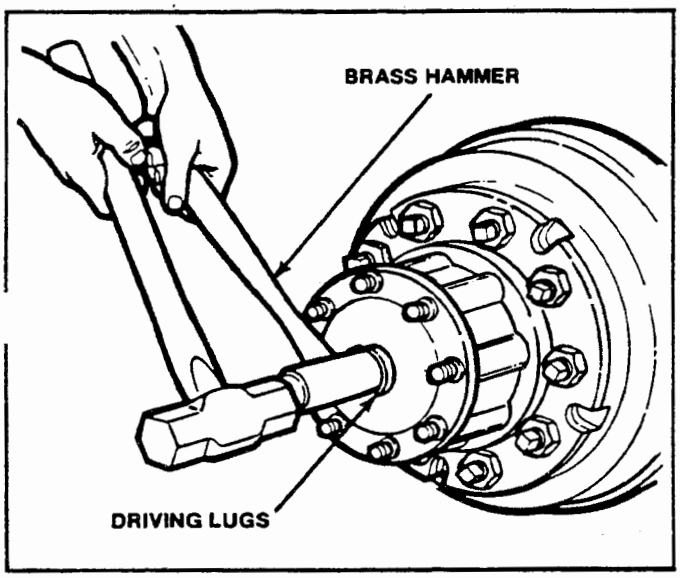


Figure 2-7. Loosening Shaft And Dowels.

NOTE: A 1½-inch-diameter brass hammer can be used as a drift.

b. Hit the end of the drift with a large hammer (five to six pounds) and the axle shaft and tapered dowels will loosen.

CAUTION: Do not use a chisel or wedge to loosen the axle shafts and dowels. The chisel or wedge can damage the hub, axle shafts and oil seals.

5. Remove the tapered dowels and both axle shafts from the axle assembly.

6. Place a hydraulic roller jack under the differential carrier to support the assembly (Figure 2-8).

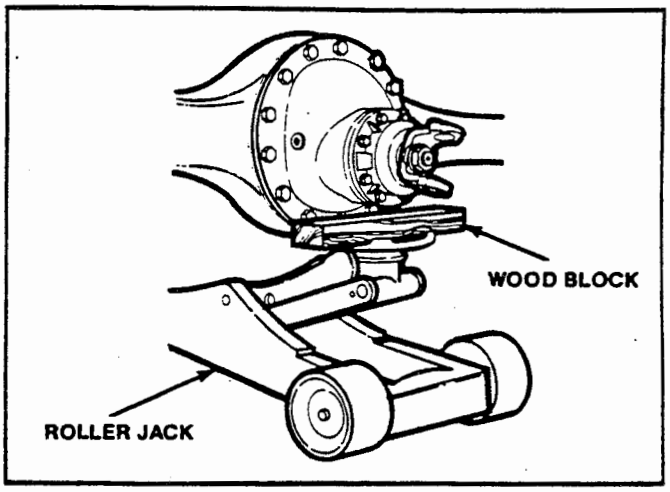


Figure 2-8. Supporting Carrier Assembly.

7. Remove all but the top two carrier-to-housing capscrews or stud nuts and washers.

8. Loosen the top two carrier-to-housing fasteners and leave attached to the assembly. The fasteners will hold the carrier in the housing.

9. Loosen the differential carrier in the axle housing. Use a leather mallet to hit the mounting flange of carrier at several points.

NOTE: Some carrier models have threaded puller screw holes in the mounting flange. Puller screws can be used to loosen and pull the carrier from the axle housing. If puller screws are used, clean the threaded holes before the puller screws are installed.

10. After carrier is loosened, remove the top two fasteners. Carefully remove the carrier from the axle housing using the hydraulic roller jack. Use a pry bar that has a round end to help remove the carrier from the housing.

CAUTION: When using a pry bar be careful not to damage the carrier or housing flange. Damage to these surfaces will cause oil leaks.

11. Remove and discard the carrier-to-housing gasket.

12. Lift the differential carrier by the input yoke or flange and put the assembly in a repair stand. Figure 2-9 shows the carrier in a stand. Such a stand may be purchased; see tools at end of this section. Do not lift the carrier assembly by hand; use a lifting tool.

MC-9 MAINTENANCE MANUAL

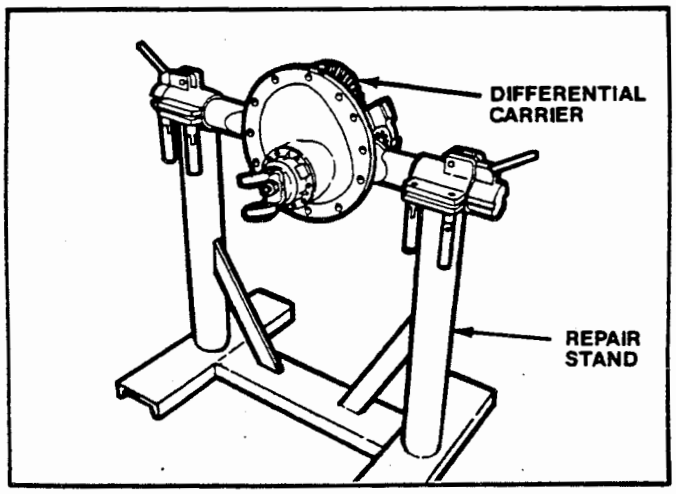


Figure 2-9. Carrier Mounted In Repair Stand.

REMOVAL OF DIFFERENTIAL AND RING GEAR

NOTE: Before starting work on the differential carrier, inspect the hypiod gear set for damage. If the inspection shows no damage, the same gear set can be used again. Using a dial indicator as shown in Figure 2-10, measure the backlash of the gear set and make a note of it. This measurement will be needed when the set is reinstalled.

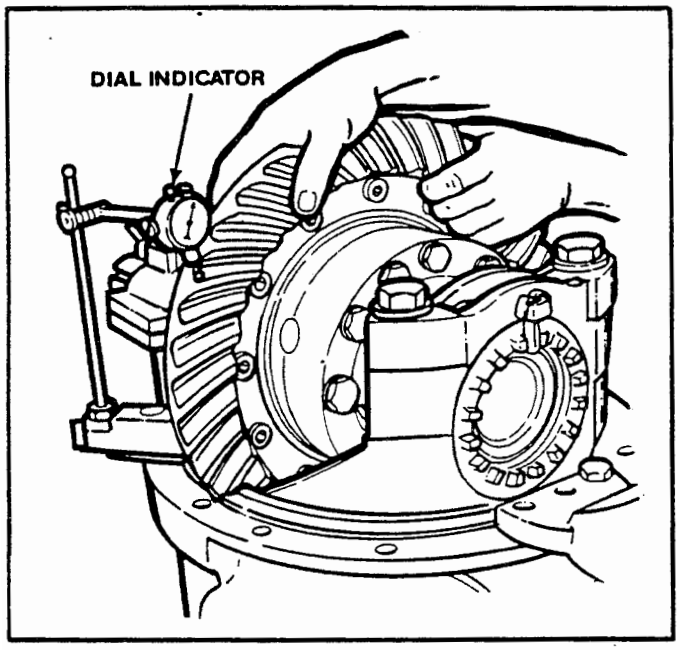


Figure 2-10. Measuring Backlash.

1. Loosen the jam nut on the thrust screw.

2. Remove the thrust screw and jam nut from the differential carrier (Figure 2-11).

3. Rotate the differential carrier in the repair stand until the ring gear is at the top of the assembly.

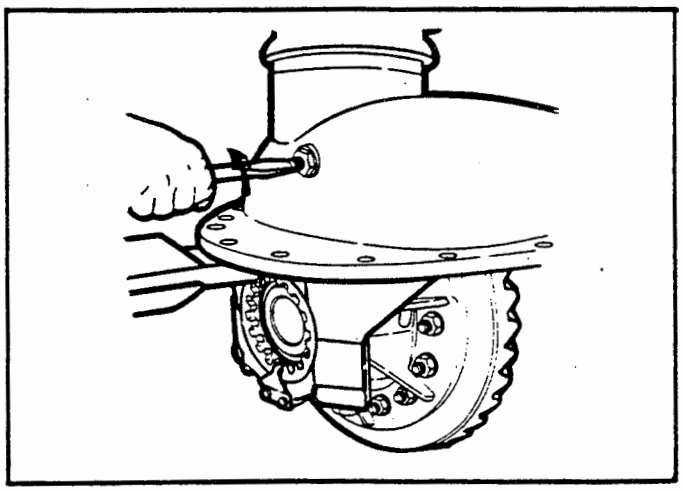


Figure 2-11. Removing Thrust Screw And Jam Nut.

4. Mark one carrier leg and bearing cap for the purpose of correctly matching the parts when you assemble the carrier. A center punch and hammer can be used to mark the parts (Figure 2-12).

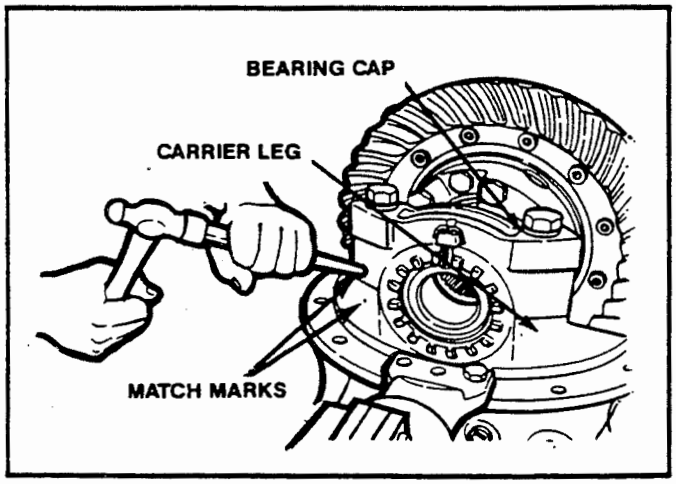


Figure 2-12. Making Match Marks.

5. Remove the cotter keys, pins or lock plates that hold the two bearing adjusting rings in position. Use a small drift and hammer to remove pins. Each lock plate is held in position by two capscrews (Figure 2-13).

MC-9 MAINTENANCE MANUAL

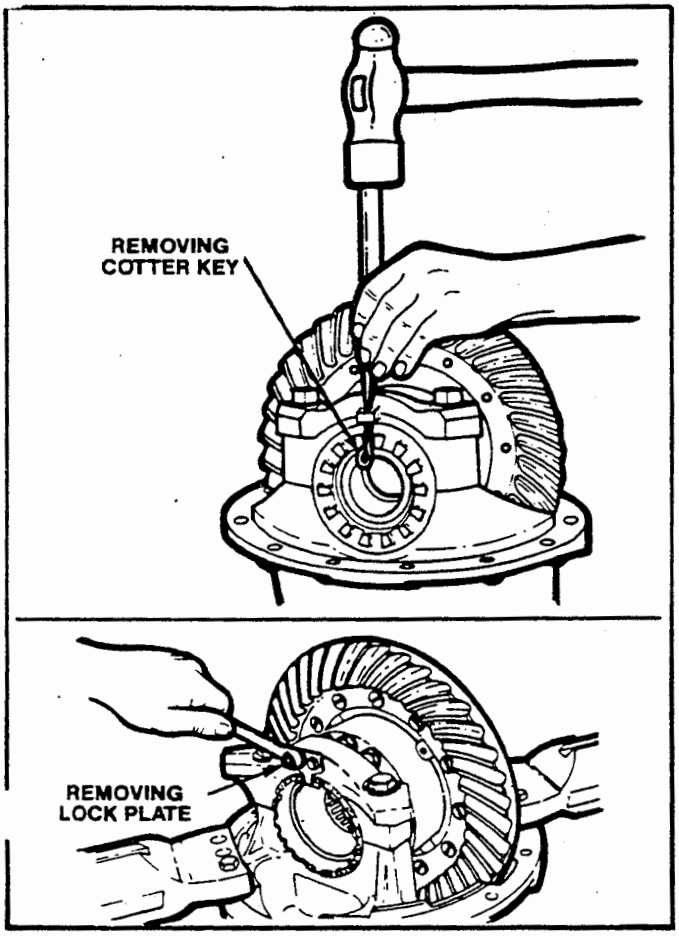


Figure 2-13. Cotter Key/Lock Plate Removal.

6. Remove the capscrews and washers that hold the two bearing caps on the carrier. Each cap is held in position by two capscrews and washers (Figure 2-14).

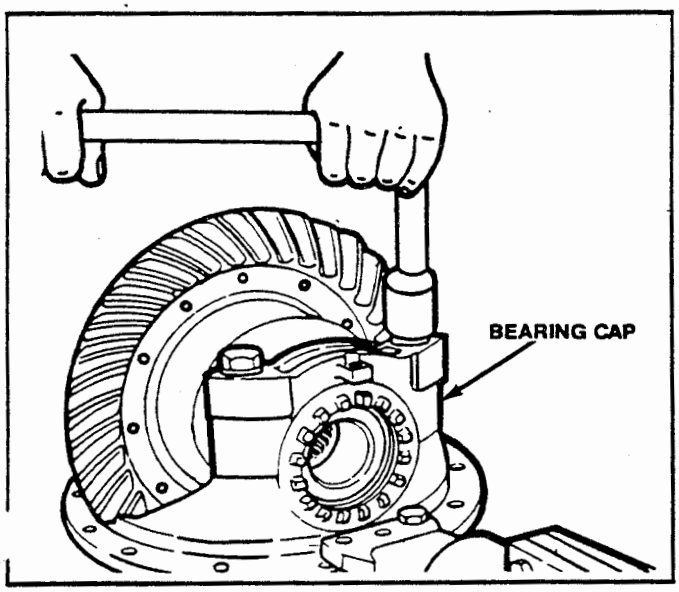


Figure 2-14. Removal of Bearing Cap Capscrews.

7. Remove the bearing caps and bearing adjusting rings from the carrier (Figure 2-15).

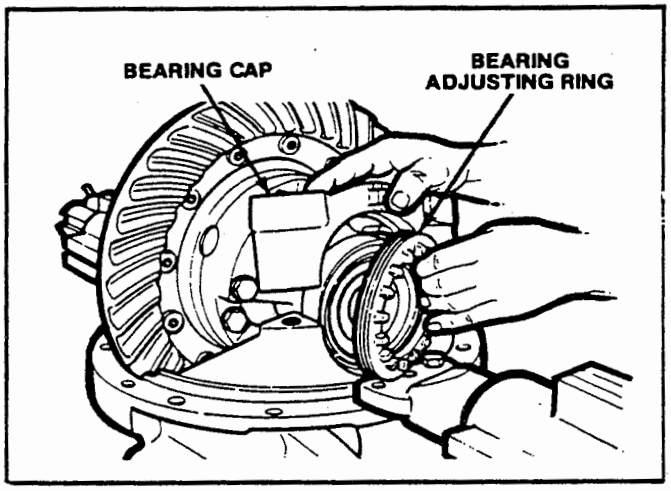


Figure 2-15. Removing Bearing Cap And Adjusting Ring.

8. Safely lift the main differential and ring gear assembly from the carrier. Put the assembly on a work bench (Figure 2-16).

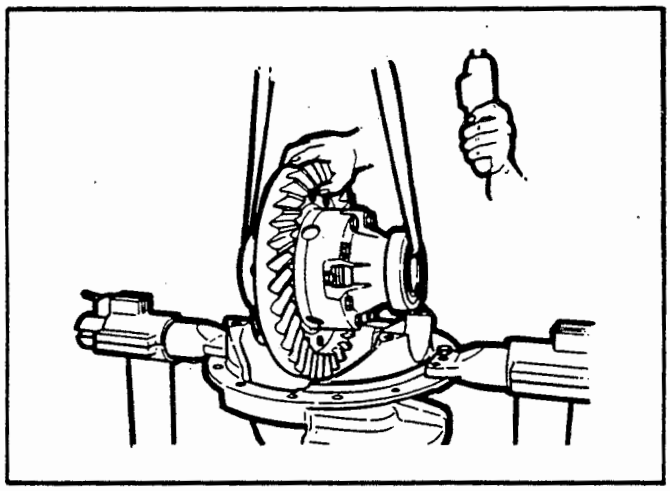


Figure 2-16. Lifting Differential And Ring Gear From Carrier.

DISASSEMBLING THE DIFFERENTIAL AND RING GEAR ASSEMBLY

1. If the matching marks on the case halves of the differential assembly are not visible, mark each case half with a center punch and hammer. The purpose of the marks is to match the plain half and flange half correctly when you assemble the carrier (Figure 2-17).

2. Remove the lock wire, capscrews and washers or bolts, nuts and washers that hold the case halves together.

WARNING: Wear eye protection. Do not hit steel parts with a steel hammer. Parts can break and cause injury.

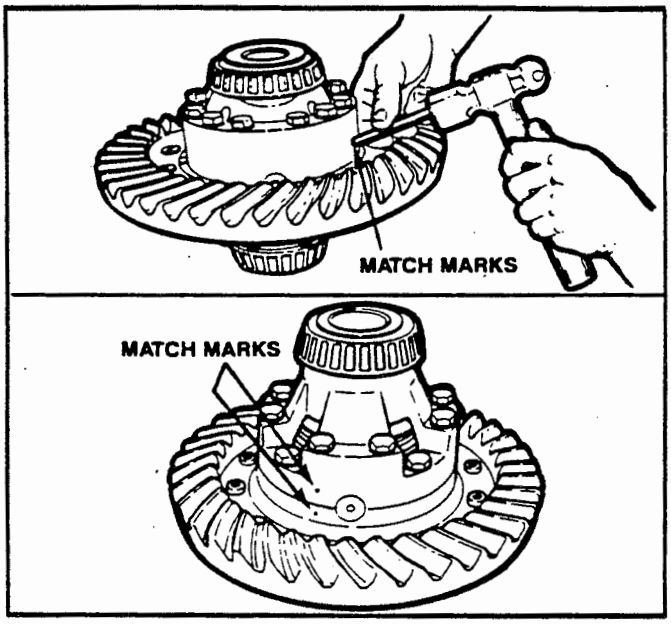


Figure 2-17. Putting Match Marks On Case Halves.

3. Separate the case halves. If necessary, use a brass, plastic or leather mallet to loosen the parts.

4. Remove the differential spider (cross), four pinion gears, two side gears and six thrust washers from inside the case halves (Figure 2-18).

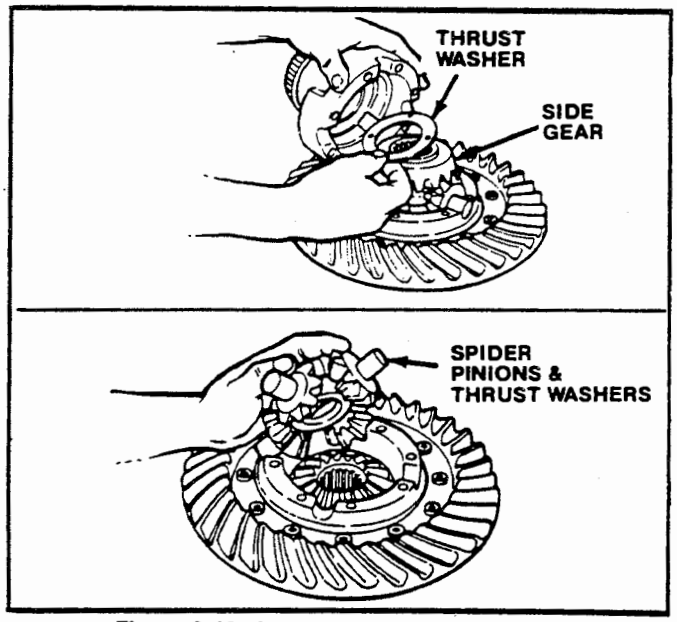


Figure 2-18. Disassembling Differential.

5. If the ring gear needs to be replaced, remove the bolts, nuts and washers that hold the gear to the flange case half; if rivets hold the ring gear to the flange case half, remove the rivets as follows.

a. Carefully center punch each rivet head in the center, on the ring gear side of the assembly.

b. Drill each rivet on the ring gear side of the assembly to a depth equal to the thickness of one rivet head. Use a drill bit that is 1/32 to an inch smaller than the body diameter of the rivets.

c. Press the rivets through holes in the ring gear and flange case half. Press from the drilled rivet head.

CAUTION: Do not remove the rivets or rivet heads with a chisel and hammer. The chisel can damage the flange case half.

6. Separate the case half and ring gear using a press. Support the assembly under the ring gear with metal or wood blocks and press the case half through the gear (Figure 2-19).

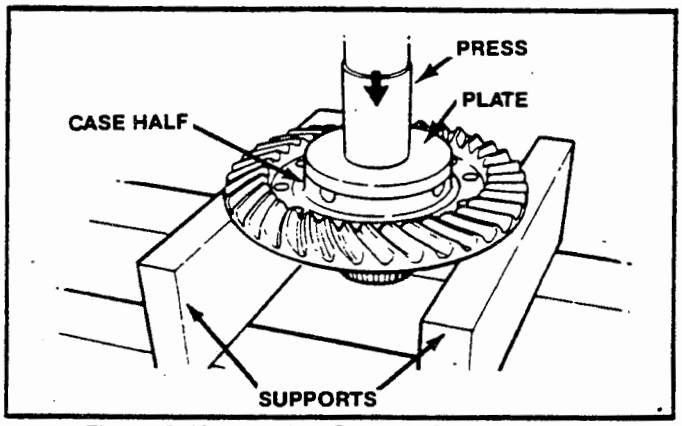


Figure 2-19. Pressing Case Half From Gear.

7. If the differential bearings need to be replaced, remove the bearing cones from the case halves. Use a bearing puller or press (Figure 2-20).

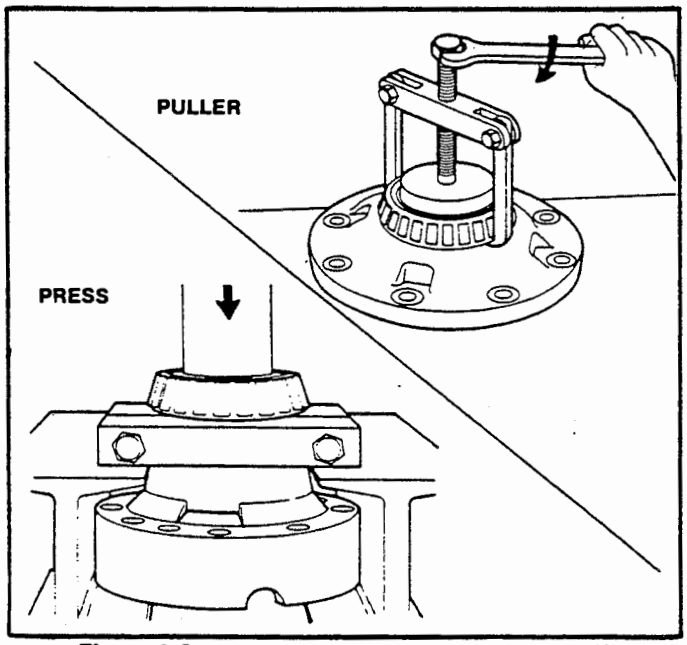


Figure 2-20. Removing Bearing From Case Half.

REMOVING DRIVE PINION AND BEARING CAGE FROM CARRIER

1. Fasten a yoke or flange bar to the input yoke or flange. The bar will hold the drive pinion in position when the nut is removed. Remove the nut and washer from the drive pinion (Figure 2-21).

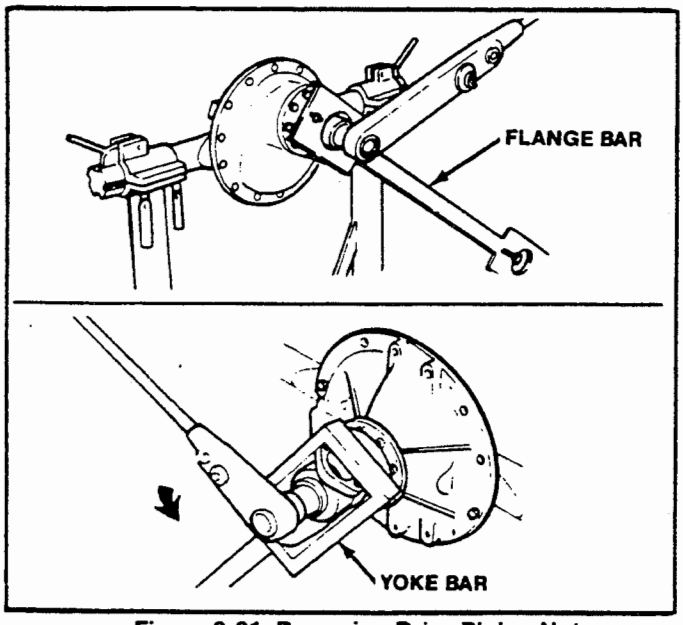


Figure 2-21. Removing Drive Pinion Nut.

2. Remove the yoke or flange bar.

3. Remove the yoke or flange from the drive pinion. If the yoke or flange is tight on the pinion, use a puller for removal (Figure 2-22).

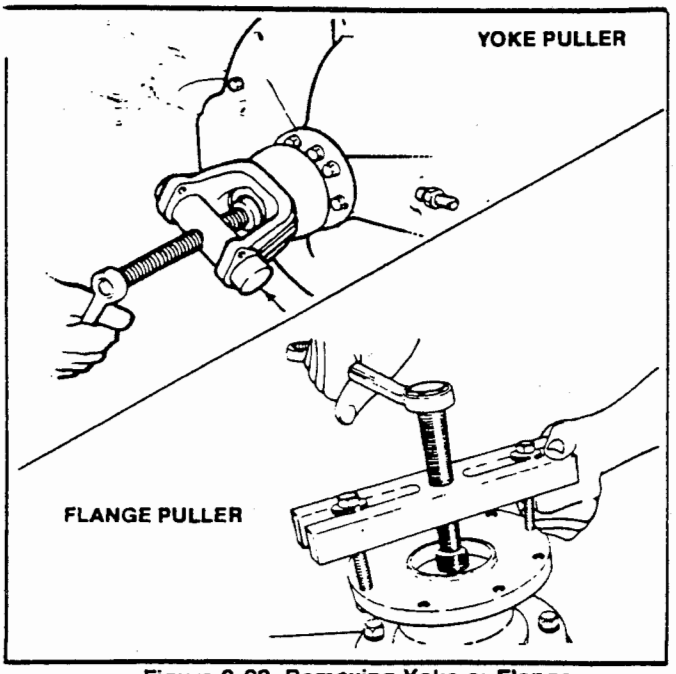


Figure 2-22. Removing Yoke or Flange.

CAUTION: Do not use a hammer or mallet to loosen and remove the yoke or flange. A hammer or mallet can damage the parts and cause runout or alignment problems.

4. Remove the capscrews and washers that hold the bearing cage in the carrier (Figure 2-23).

5. If the pinion seal is damaged, remove the seal from the cover. Use a press and sleeve or seal driver. If a press is not available, use a screwdriver or small pry bar for removal. Discard the pinion seal.

6. The pinion seal is mounted in the outer bore of the bearing cage. Remove the seal after the drive pinion is removed from the bearing cage.

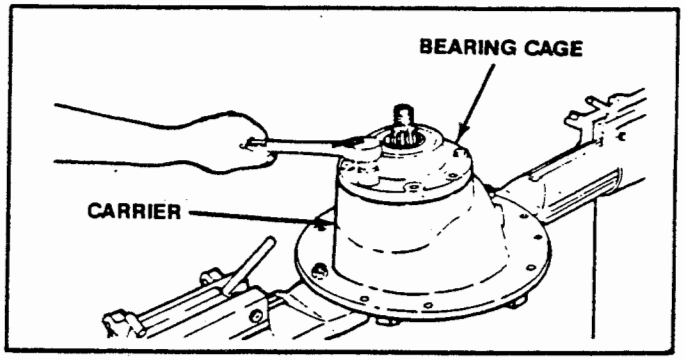


Figure 2-23. Removing Bearing Cage Capscrews.

7. Remove the drive pinion, bearing cage and shims from the carrier. If the bearing cage is tight in the carrier, use the following procedures to loosen the cage (Figure 2-24).

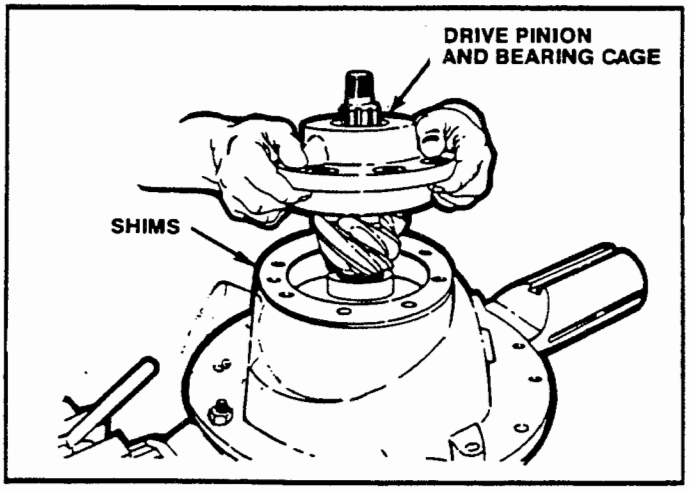


Figure 2-24. Removing Drive Pinion And Bearing Cage.

WARNING: Wear safe eye protection. Do not hit steel parts with a steel hammer. Parts can break and cause injury.

a. Hit the bearing cage at several points around the flange areas with a leather, plastic or rubber mallet.

b. Some bearing cages have threaded puller screw holes in the mounting flange. Puller screws can be used to loosen and pull a tightly fitted cage from the carrier. If puller screws are used, clean the threaded holes before the puller screws are installed (Figure 2-25).

CAUTION: Do not use a pry bar to remove the bearing cage from the carrier. A pry bar can damage the bearing cage, shims and carrier.

8. If the shims are in good condition, keep the shims together for use later when the carrier is assembled.

9. If shims are to be discarded because of damage, first measure the total thickness of the pack. Make a note of the dimension. The dimension will be needed to calculate the depth of the drive pinion in the carrier when the gear set is installed.

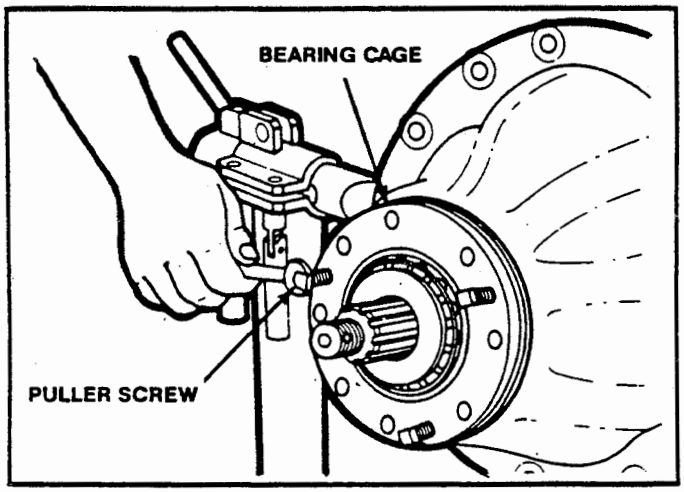


Figure 2-25. Removing Bearing Cage Using Puller Screws.

DISASSEMBLING THE DRIVE PINION AND BEARING CAGE

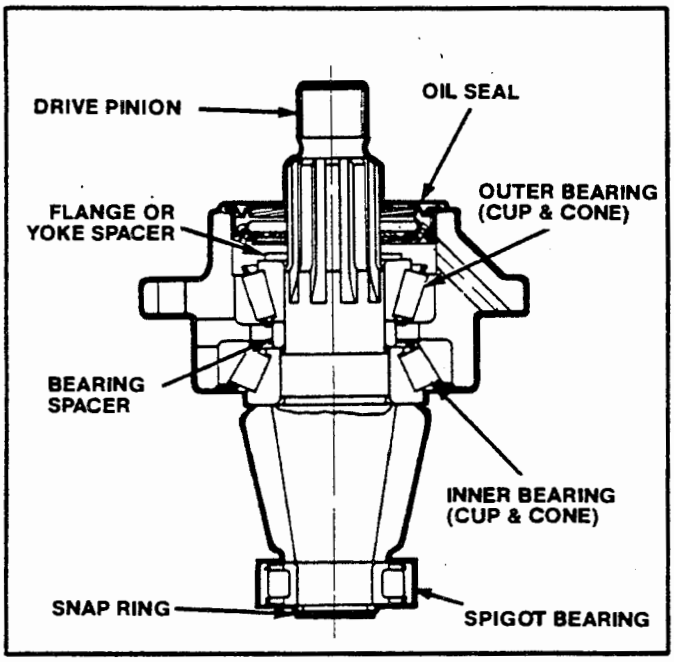


Figure 2-26. Pinion And Bearing Cage Assembly.

1. Put the drive pinion and bearing cage (figure 2-26) in a press. The pinion shaft must be toward the top of the assembly. Support the bearing cage under the flange area with metal or wood blocks. Press the drive pinion through the bearing cage (Figure 2-27).

NOTE: The inner bearing cone and bearing spacer or spacers will remain on the pinion shaft.

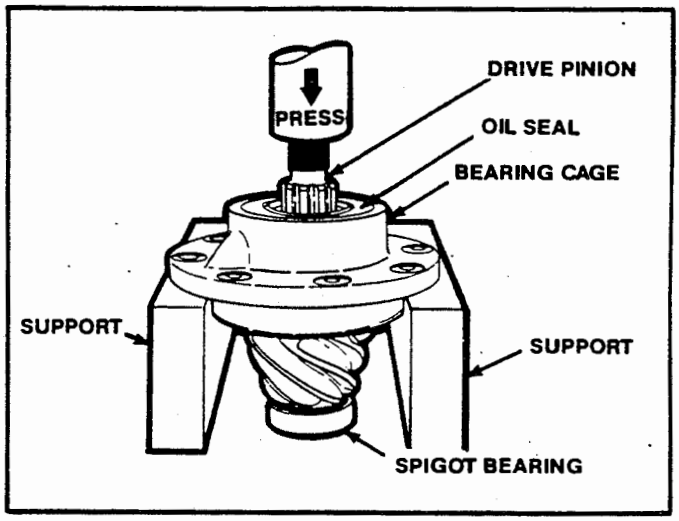


Figure 2-27. Removing Drive Pinion From Bearing Cage.

2. If a press is not available, use a leather, plastic or rubber mallet to drive the pinion through the bearing cage.

3. If the pinion seal is mounted directly in the outer bore of the bearing cage, remove the seal at this time. Use a screwdriver or small pry bar for removal. After the seal is removed, lift the outer bearing cone from the cage (Figure 2-28).

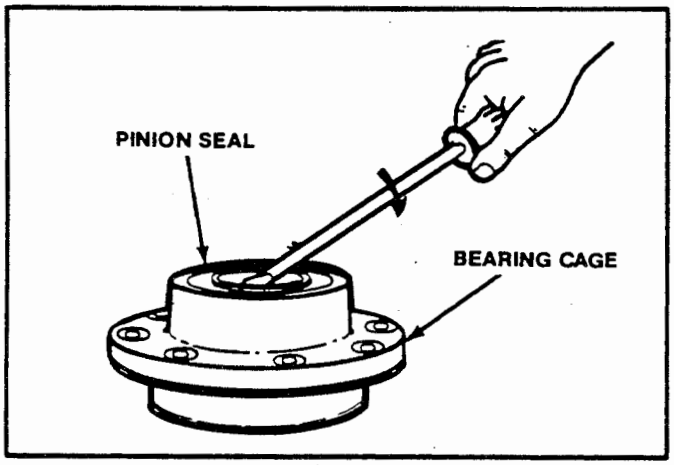


Figure 2-28. Removing Pinion Seal.

CAUTION: Be careful when using a screwdriver or pry bar to remove the seal. Do not damage the wall of bore. Damage to the bore can cause oil leaks.

4. If the pinion bearings need to be replaced, remove the inner and outer bearing cups from the inside of the cage. Use a press and sleeve, bearing puller or a small drift and hammer. The type of tool used depends on the design of the bearing cage.

When a press is used, support the bearing cage under the flange area with metal or wood blocks (Figure 2-29).

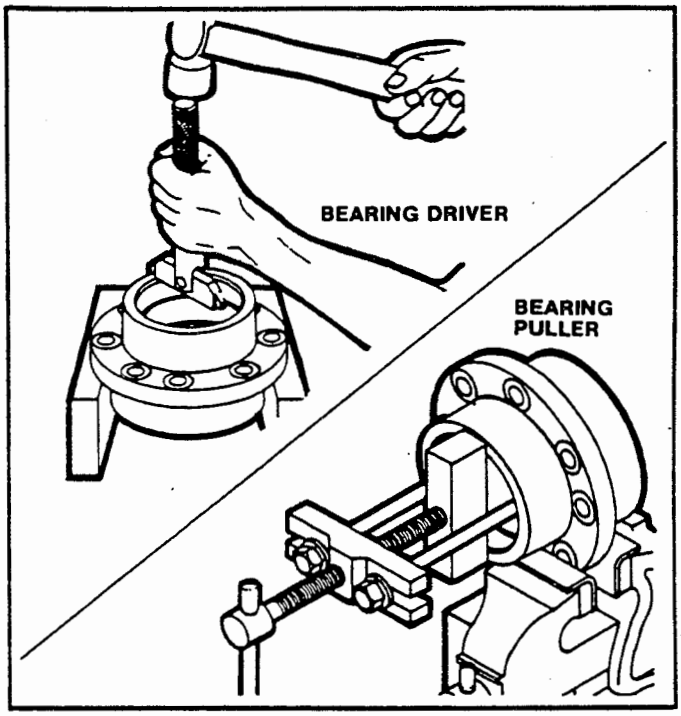


Figure 2-29. Removing Bearing Cups.

5. If the pinion bearings need to be replaced, remove the inner bearing cone from the drive pinion with a press or bearing puller. The puller **must** fit under the inner race of the cone to remove the cone correctly without damage (Figure 2-30).

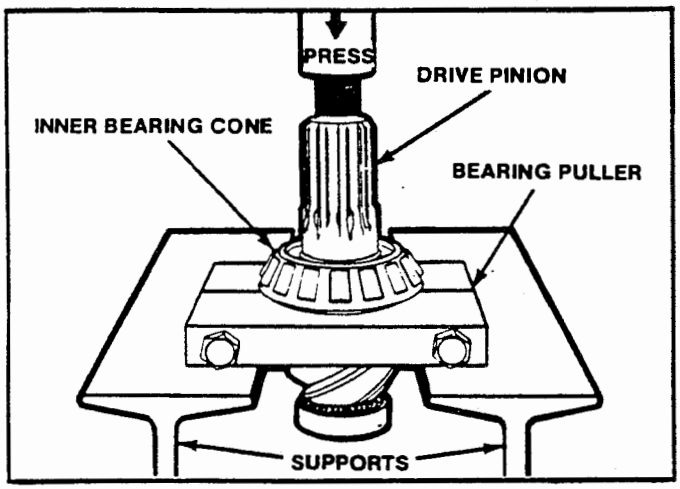


Figure 2-30. Removing Inner Bearing Cone.

6. If the spigot bearing needs to be replaced, put the drive pinion in a vise. Install a soft metal cover over each vise jaw to protect the drive pinion.

Remove the snap ring from the end of drive pinion with snap ring pliers that expand (Figure 2-31).

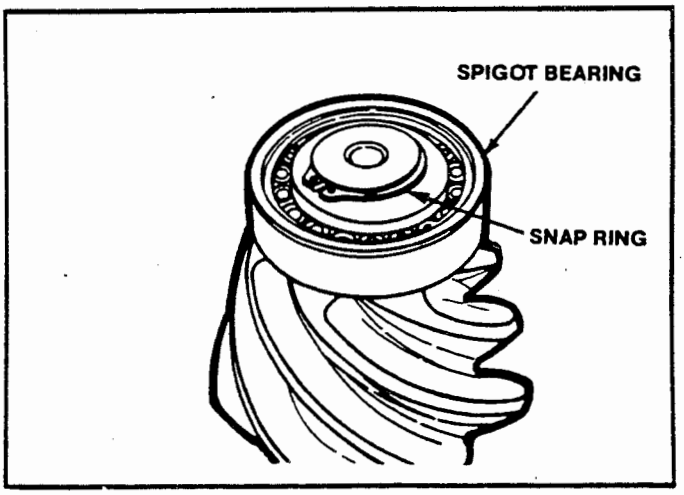


Figure 2-31. Snap Ring On Drive Pinion.

8. Remove the spigot bearing from the drive pinion with a bearing puller (Figure 3-32).

NOTE: Some spigot bearings are a two-piece assembly. Remove the inner race from the pinion with a bearing puller. Remove the outer race/roller assembly from carrier with a drift or a press.

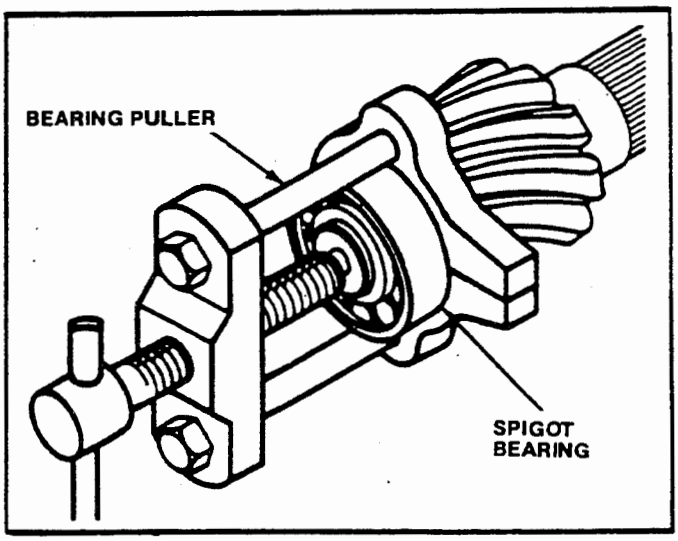


Figure 2-32. Removing Spigot Bearing From Drive Pinion.

GENERAL PROCEDURES BEFORE REASSEMBLY

CLEANING OF PARTS

It is important that all parts being reassembled are clean. Foreign material in the assembly will cause abrasion of parts and shorten their life.

To Clean Ground and Polished Parts:

1. Use a cleaning solvent to clean ground or polished parts or surfaces. Kerosene or diesel fuel oil can be used for this purpose. Do not use gasoline. Follow the solvent manufacturer's instructions for safe use to prevent injury.
2. Use a tool with a flat blade if required to remove gasket material from parts. Be careful not to damage the ground surfaces.
3. **Do not** clean ground or polished parts in a hot solution tank, water, stream or alkaline solutions.

To Clean Rough Parts:

1. Clean rough parts the same as cleaning ground and polished parts.
2. Rough parts can be cleaned in hot solution tanks with a weak alkaline solution.
3. Parts must remain in hot solution tanks until completely cleaned and heated. Follow the alkaline product manufacturer's instructions for safe use to prevent injury.
4. Parts must be washed with water until the alkaline solution is removed.

To Clean Axle Assemblies:

1. A complete axle assembly can be steam cleaned on the outside to remove dirt.
2. Before the axle is steam cleaned, close or put a cover over all openings in the axle assembly. Examples of openings are breathers or vents in air chambers.

To Dry Parts That Have Been Cleaned:

1. Parts must be dried immediately after cleaning and washing.
2. Dry the parts using soft, clean paper or cloth rags.
3. Except for bearings, parts can be dried with compressed air

CAUTION: Damage to bearings can be caused if dried by rotating with compressed air.

To Prevent Corrosion and Rust on Cleaned Parts:

1. Apply axle lubricant to cleaned and dried parts that are not damaged and are to be assembled.
2. To store parts, apply a special material that prevents corrosion and rust to all surfaces. Wrap them in a special paper that prevents corrosion and rust.

INSPECTING OF PARTS

It is very important to inspect all parts carefully and completely before the axle or carrier is assembled. Check all parts for wear and replace damaged parts. Replacement of damaged or worn parts now will prevent failure of the assembly later.

1. Inspect Tapered Roller Bearings — Inspect the cup, cone, rollers and cage of all tapered roller bearings in the assembly. If any of the following conditions exist, the bearing must be replaced.

a. The center of large diameter end of rollers worn level with or below the outer surface.

b. The radius at large diameter end of rollers worn to a sharp edge.

c. A visible roller groove in the cup or cone inner race surfaces. The groove can be seen at the small or large diameter end of both parts.

d. Deep cracks or breaks in the cup, cone inner race or roller surfaces.

e. Bright wear marks on the outer surface of the roller cage.

f. Damage on rollers and on surfaces of the cup and cone inner race that touch the rollers.

g. Damage on the cup and cone inner race surfaces that touch the rollers.

2. Inspect Hypoid Drive Pinion and Ring Gear Sets: Inspect hypoid pinions and gears for wear or damage. Gears that are worn or damaged must be replaced.

CAUTION: Hypoid drive pinions and ring gears are machined in matched sets. When a drive pinion or ring gear of a hypoid set needs to be replaced, both drive gear and pinion must be replaced at the same time.

3. Inspect the Main Differential Assembly: Inspect the following parts for wear or stress. Parts that are damaged must be replaced (Figure 2-33).

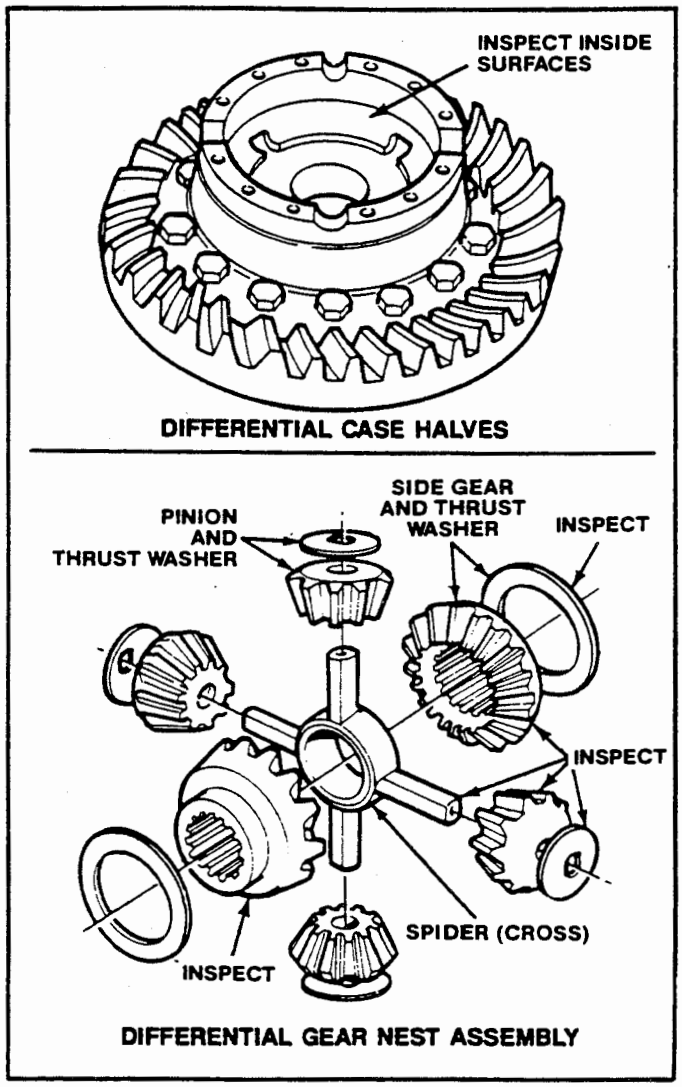


Figure 2-33. Inspection Points.

a. Inside surfaces of both case halves.
b. Both surfaces of all thrust washers.
c. The four trunnion ends of the spider (cross).
d. Teeth and splines of both differential side gears.
e. Teeth and bore of all differential pinions.

CAUTION: Always replace thrust washers, differential side gears and pinion gears in sets. A higher stress on parts and early failure of the assembly will occur if a new part is used with parts that are old or worn.

4. Inspect Axle Shafts: Inspect axle shafts for wear and cracks at the flange, shaft and splines. Replace axle shaft if required.

REPAIRING AND REPLACING FASTENERS

All threads of the fasteners and holes in the assembly must be without damage and clean so that accurate adjustments and correct torque values can be applied to the fasteners and parts.

Use the following procedures to ensure that all fasteners and threaded holes are in good condition.

1. Replace any fastener if the corners of the head are worn or distorted.
2. Clean and repair threads of fasteners and holes. Use a die or tap of the correct size or a fine file for this purpose.
3. Replace any damaged washer.
4. When installing new fasteners of the "Dri-Loc" type, **do not** apply adhesives or sealants to the new fastener or to the hole. The "Dri-Loc" adhesive will not function correctly if this is done.
5. When the old fasteners are being reused:

a. Clean the oil and dirt from threaded holes. There is no special cleaning required and it is not necessary to remove the old Dri-Loc adhesive from threads.

b. Apply four or five drops of Rockwell Liquid Adhesive or Loctite 277 to threaded holes **only.** Make sure the adhesive is on the threads. CAUTION: Do not apply adhesive to the fastener threads. Air pressure in the hole will push the adhesive out as the fastener is installed.

INSTALLING FASTENERS

When installing the fasteners, torque to the required value for that size fastener. See Torque Value Chart later in this section. Always use a torque wrench (Figure 2-34).

CHECKING TORQUE OF UNREMOVED FASTENERS

If Dri-Loc fasteners do not require removal from components, check the fasteners for correct torque value as follows:

1. Apply the minimum amount of torque required for that size fastener. See the torque chart later in this section. The fastener must not rotate (Figure 2-34).
2. If the fastener rotates any amount, remove the fastener from the component and apply adhesive to the threaded hole. Follow the procedure for installing old Dri-Loc fasteners.

MOVAL OF "DRI-LOC" FASTENERS

If it is difficult to remove Dri-Loc fasteners from components, the strength of Dri-Loc, Rockwell adhesive or Loctite 277 can be decreased by heating. Use the following procedure:

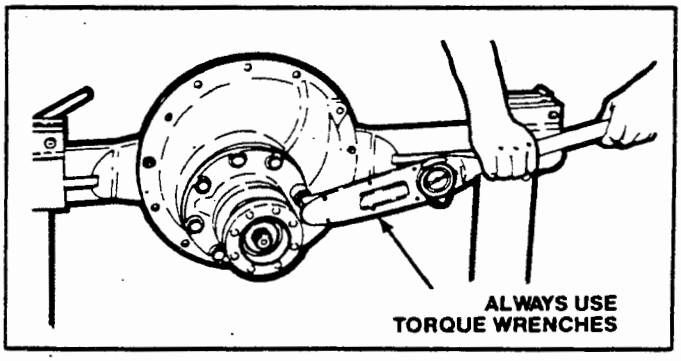


Figure 2-34. Reinstalling Fasteners.

1. Heat the fastener for three to five seconds **only** and try to loosen the fastener with a wrench. **Do not** use an impact wrench to loosen the fastener or hit the fastener with a hammer.
2. Repeat step 1 until the fastener can be removed.

CAUTION: Do not exceed 350°F (+177°C) maximum. Heating must be done slowly to prevent thermal stresses in the other components.

REPAIRING PARTS

Remove nicks, mars and burrs from parts having machined or ground surfaces. Use a fine file, india stone, emery cloth or crocus cloth for this purpose.

REPAIRING AXLE HOUSING

Certain repairs may be made to the axle housing, by welding — see below. However, attempted repairs of the housing by bending or straightening will cause poor or unsafe operation of the axle and early failure can result.

NOTE: Refer to the welding caution in the introductory pages of this manual before starting any welding operation.

Following is the vendor-allowed welding procedure which can be done on the drive axle housing, The vendor, Rockwell International, will permit repairing drive axle housing assemblies by welding ONLY in the following areas:

1. Cover welds.
2. Snorkel welds.
3. Housing seam welds between the suspension attaching brackets.

CAUTION: Welding can be used when the crack or damaged area is within the old weld material. Replace the axle housing if the crack extends into the metal next to the old weld. A housing that has damage in the seam weld or cover weld because of overload conditions can be repaired. A repaired housing must be used in correct applications.

WARNING: Using wrong welding procedures or welding at locations other than the three areas permitted by Rockwell will make the heat-treated component weak. A weak component will cause poor or unsafe operation of the axle and early failure. The following procedure must be used.

WELDING PROCEDURE

1. Drain the lubricant from the axle assembly.
2. Remove the axle shafts and differential carrier from the axle housing.
3. Clear the damaged area inside and outside the housing. Cleaning solvent can be used.

WARNING: Be careful when using a cleaning solvent. Follow the solvent manufacturer's instructions for safe use to prevent injury.

4. Grind the damaged weld to the base metal.
5. Warm the complete axle housing to a temperature of 70°F-80°F (21°C-27°C) or higher.
6. Before you start welding, heat the damaged area to be repaired to approximately 300°F (149°C).
7. Use a 70,000 psi tensile weld material and the correct voltage and amperage for the diameter weld rod used. Examples of weld rods that can be used are E-7018 or ER-70S-3.

CAUTION: If the E-7018 weld rod is used, the rod must be kept dry. Electrodes that are not stored in the correct sealed containers must be heated at 700°F (371°C) for one hour before welding. Wet electrodes must be dried at 180°F (82°C) for one to two hours and then heated at 700°F (371°C) for one hour before welding.

8. Fill in the Weld Gap as follows:

CAUTION: Do not connect the ground cable at any point on the axle assembly that will put a bearing between the ground cable and weld area. If a bearing is between the ground cable and weld, the bearing will be damaged because of electricity arcing. A good location to connect the ground cable is the spring mounting pad of the housing.

a. The snorkel weld must be a .375 inch (9.5 mm) fillet.
b. The opening in cover welds must be filled level with the old weld.
c. The opening in seam welds must be ground out to 70% of the wall thickness. The wall thickness can be measured at the carrier opening of housing.
d. Clean the new weld area. Carefully remove all the rough weld material.
e. Install the differential carrier and axle shafts.
f. Fill the axle assembly with the correct amount of lubricant. See Section 10 (Lubrication) of this manual.

NOTE: To weld brackets or other components to the axle housing, use the procedure in Rockwell Technical Service Aid, TSA-2-95.

REPLACING GASKET AND SEALS

At the time of axle or carrier repair, all gaskets, oil seals or grease seals should be replaced.

Silicone gasket material is used at mating surfaces of the carrier housing and the axle housing. When carrier assembly is being re-installed in the axle:

1. Remove all old gasket material from both surfaces (Figure 2-35).
2. Clean the surfaces where silicone gasket material will be applied. Remove all oil, grease, dirt and moisture.
3. Dry both surfaces.
4. Apply a ⅛-inch-diameter continuous bead of the silicone gasket material around one surface. Also apply the gasket material around the edge of all fastener holes in that surface (Figure 2-35).

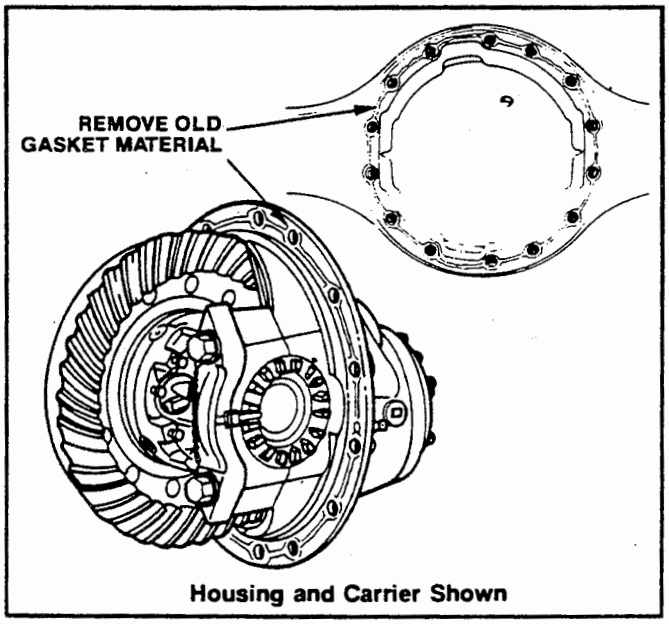


Figure 2-35. Replacing Silcone Gasket.

CAUTION: The amount of silicone gasket material applied must not exceed a ⅛-inch-diameter bead. Too much gasket material can block lubrication passages.

5. Assemble the components immediately to permit the silicone gasket material to compress evenly between the parts. Tighten fasteners to the required torque value for that size fastener. See Torque Chart later in this section.
6. Wait 20 minutes before the assembly is filled with lubricant.

NOTE: The following silicone gasket products can be used.

a. Dow Corning Silicone Rubber Sealant, No. 732 Black.

b. General Electric No. RTV-1473 Black.

WARNING: Small amounts of acid vapor are present when applying silicone gasket material. For this reason, be sure there is good ventilation in the work area. If the silicone gasket material gets in the eyes, flush the eyes with water for 15 minutes. Have the eyes checked by a doctor.

APPLICATION OF ADHESIVE IN BEARING BORES FOR THE DIFFERENTIAL

A special adhesive (Rockwell part number 2297-T-4108) is used in the bearing bores for the differential. Apply as follows:

1. Clean the oil and dirt from outer diameters of bearing cups and bearing bores in the carrier and bearing caps. There is no special cleaning required.
2. Apply axle lubricant to the bearing cones and the inner diameters of the bearing cups of the main differential. **Do not** get oil on the outer diameter of the bearing cup and **do not** permit oil to drip on the bearing bores.
3. Apply a single continuous bead of the adhesive to the bearing bores in the carrier and bearing caps. Apply the adhesive 360° around the smooth, ground surfaces **only. Do not** put adhesive on threaded areas (Figure 2-36).

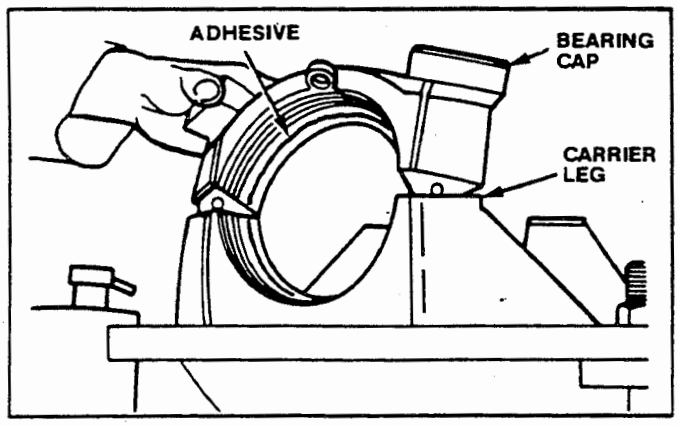


Figure 2-36. Applying Adhesive To Bearing Bore.

NOTE: The Rockwell adhesive will become hard (dry) in approximately two hours. The following two steps of the procedure must be done in two hours from the time the adhesive was applied. If two hours have passed since application, clean the parts again and apply new adhesive.

4. Install the main differential assembly, bearing cups and bearing caps into the carrier. Use the normal procedure given later in this section.

5. Adjust preload of the differential bearings, backlash and tooth contact patterns of the gear set as required using the normal procedures given later in this section.

CHECKING FOR MATCHED RING GEAR AND DRIVE PINION SET

Before a new gear set is installed in the carrier, check the gear set for correct marks to make sure the gears are a matched set.

The location of the marks are shown in Figure 2-37. The numbers in the figure correspond to the following item numbers.

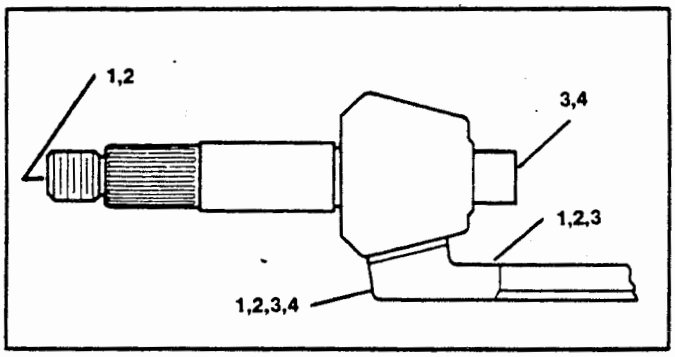


Figure 2-37. Location Of Gear Set Marks.

1. *Part Number*
   a. Examples of gear set part numbers: Ring gear, 36786; drive pinion, 36787.
   b. Location on Drive Pinion: End at threads.
   c. Location on Ring Gear: Front face or outer diameter.
2. *Tooth Combination Number*
   a. Example of a tooth combination number: 5-37.

   NOTE: A 5-37 gear set has a 5-tooth drive pinion and a 37-tooth ring gear.

   b. Location on Drive Pinion: End at threads.
   c. Location on Ring Gear: Front face or outer diameter.
3. *Gear Set Match Number* — Rockwell drive pinions and ring gears are available only as matched sets. Both gears of a set have a match number.
   a. Example of a gear set match number: M29.

   NOTE: A gear set match number has any combination of a number or letter and number.

   b. Location on Drive Pinion: End of gear head.
   c. Location on Ring Gear: Front face or outer diameter.
4. *Pinion Cone Variation Number*

   NOTE: The pinion cone variation number is not used when checking for a matched gear set. The number is used when adjusting the depth of the pinion in the carrier. See the procedure for adjusting the shim pack thickness under the pinion cage in reassembly procedure later in this section.

a. Examples of pinion cone variation numbers: PC+3, PC-5, +2, -1, +.01 mm or -.02 mm (Figure 2-38).

b. Location on Gear Set: End of pinion gear head or outer diameter of ring gear.

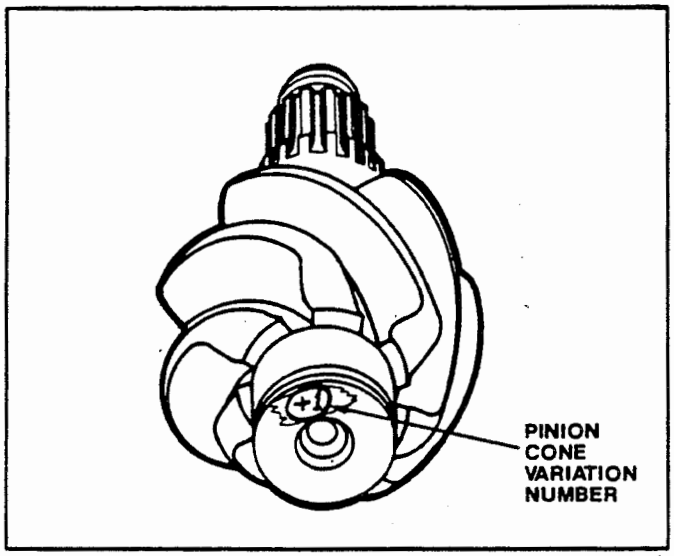


Figure 2-38. Location Of Pinion Cone Variation Number.

YOKE OR FLANGE INSTALLATION ON INTERFERENCE FIT SPLINES

CAUTION: Do not install tight fit yokes or flanges on shafts using a hammer or mallet. A hammer or mallet will damage the yoke or flange.

1. Apply axle lubricant on the yoke or flange seal.
2. Check all surfaces of the yoke or flange hub for damage. If necessary, polish the hub with an india stone, emery cloth or crocus cloth.
3. Install the pilot shaft on the input shaft of the assembly (Figure 2-39).

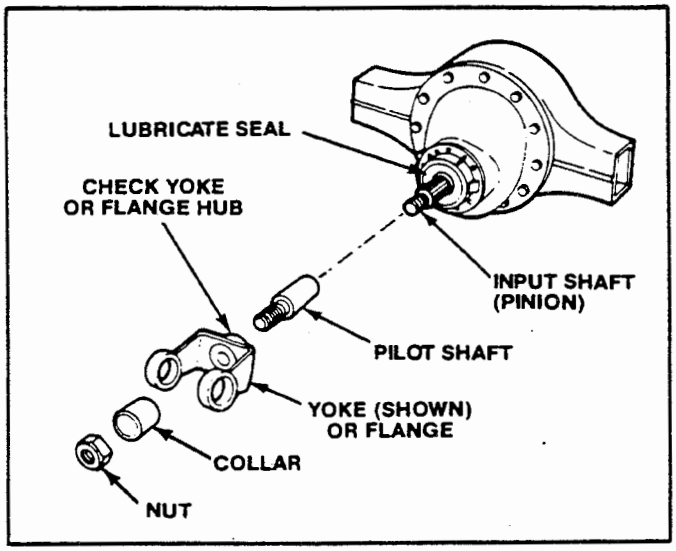


Figure 2-39. Installing Yoke Or Flange Using Pilot Tool.

4. Slide the yoke or flange over the pilot shaft. Align the yoke or flange splines with the shaft splines.
5. Put the collar on the pilot shaft and slide it against the yoke or flange.
6. Install the nut on the pilot shaft and against the collar. Tighten the nut against collar until the yoke or flange is completely in position on the shaft. Sometimes a torque value of 200 lb. ft. on the nut is required to install the yoke or flange correctly.

CAUTION: Do not use the assembly yoke or flange nut for installation purposes. Use the nut that is supplied with the three-piece pilot tool.

7. Remove all parts of the pilot tool from the shaft (pilot shaft, collar and nut).
8. Install the washer (if required) and yoke or flange nut on the shaft. Tighten the nut to minimum 800 ft. lbs. (1,085 Nm), maximum 1,100 ft. lbs. (1,492 Nm).

ASSEMBLING THE DRIVE PINION, BEARINGS AND BEARING CAGE

1. Put the bearing cage in a press (Figure 2-40).
2. Support the bearing cage with metal or wood blocks.
3. Press the bearing cup into the bore of bearing cage until cup is flat against bottom of bore. Use a sleeve of the correct size to install bearing cup (Figure 2-40).

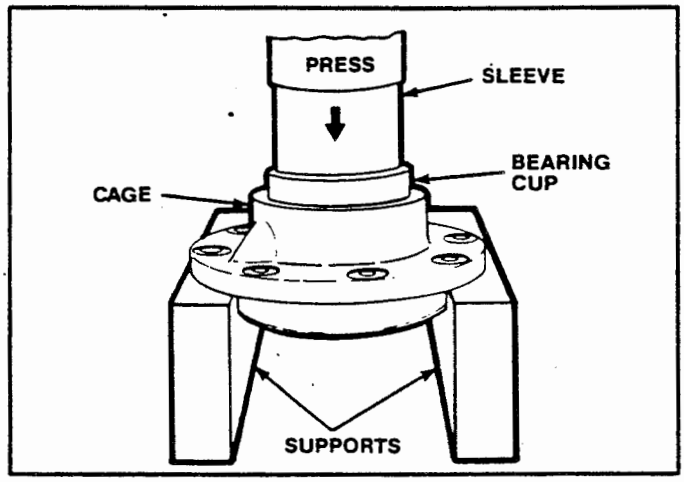


Figure 2-40. Pressing In Bearing Cup.

NOTE: Use the same procedure for both bearing cups.

4. Put the drive pinion in a press, gear head (teeth) toward the bottom (Figure 2-41).
5. Press the inner bearing cone on the shaft of the drive pinion until the cone is flat against the gear head. Use a sleeve of the correct size against the bearing inner race.

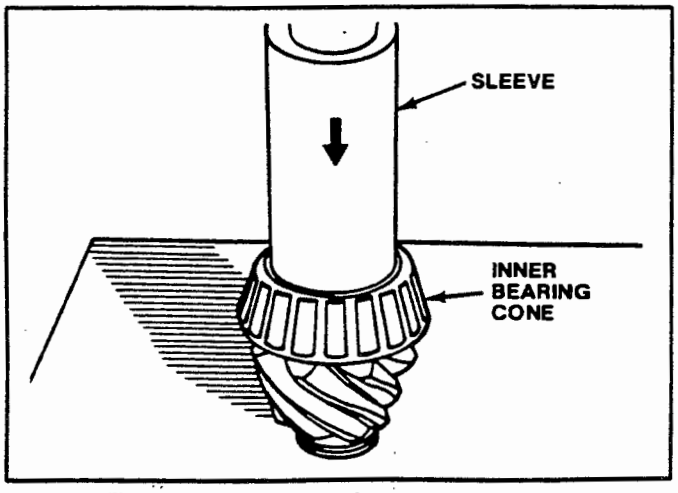


Figure 2-41. Pressing On Inner Bearing Cone.

INSTALLING SPIGOT BEARING ASSEMBLY

1. Put the drive pinion in a press, gear head (teeth) toward the top (Figure 2-42).
2. Press the spigot bearing on the end of drive pinion until the bearing is flat against the gear head. Use a sleeve of the correct size against the bearing inner race (Figure 2-42).

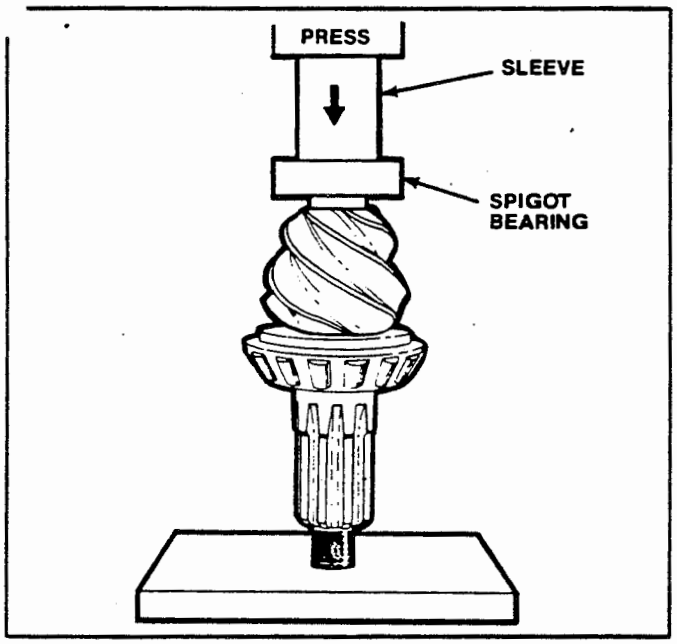


Figure 2-42. Pressing On Spigot Bearing.

3. Install the snap ring into groove in end of drive pinion with snap ring pliers (Figure 2-43).

ADJUSTING PRELOAD OF PINION BEARINGS

Specifications:

New pinion bearings - 5 to 45 lb.-in. (.56 to 5.08 Nm) torque.
Used pinion bearings in good condition - 10 to 30 lb.-in. (1.13 to 3.39 Nm) torque.

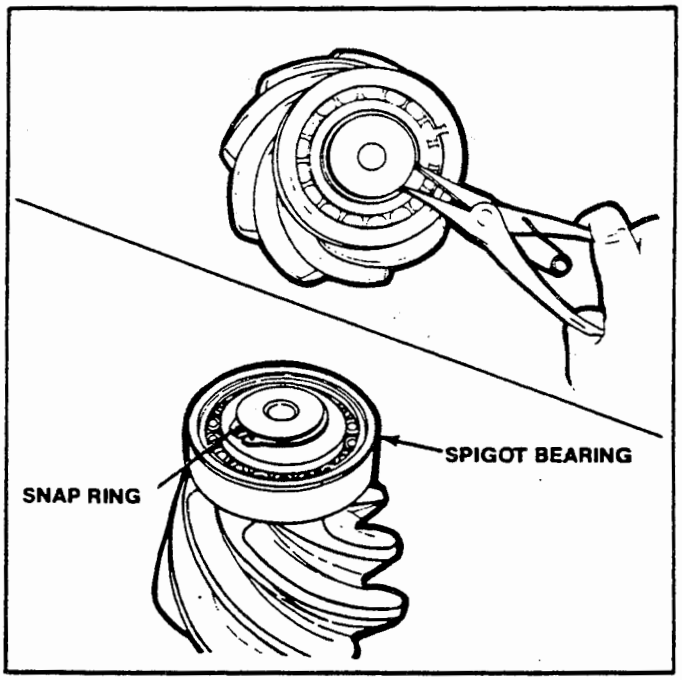


Figure 2-43. Installing Snap Ring.

Press Method

NOTE: If a press is not available, or the press does not have a pressure gauge, use the flange method to adjust preload. See later page.

1. Put the drive pinion and cage assembly in a press, gear head (teeth) toward the bottom.
2. Install a sleeve of the correct size against the inner race of the outer bearing (Figure 2-44).

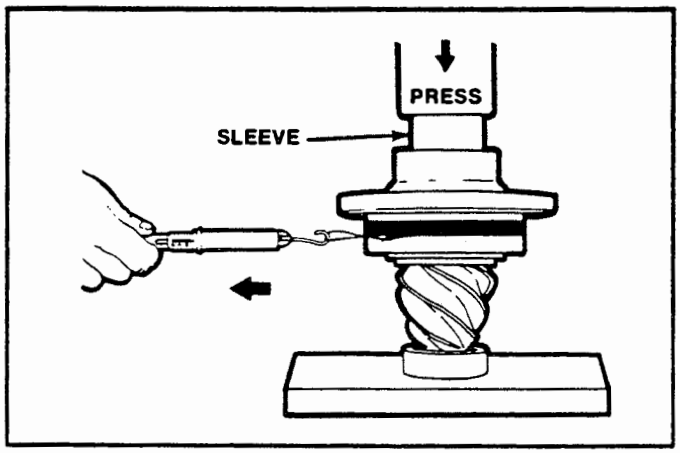


Figure 2-44. Checking Pinion Bearing Preload.

3. Apply and hold 54,000 lbs. (24,494 kg) pressure to the pinion bearings. As pressure is applied, rotate the bearing cage several times so that bearings make normal contact.
4. While pressure is held against the assembly, wind a cord around the bearing cage several times.

5. Attach a spring scale to the end of the cord.
6. Pull the cord with scale on a horizontal line. As the bearing cage rotates, read the value indicated on scale. Make a note of reading (Figure 2-44).

NOTE: Do not read starting torque. Read only the torque value after the cage starts to rotate. Starting torque will give a false reading.

7. Measure the diameter of bearing cage where the cord was wound. Measure in inches or centimeters (Figure 2-45).

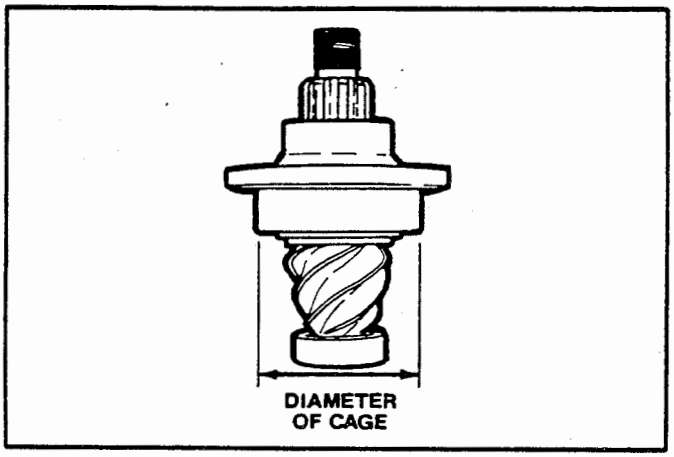


Figure 2-45. Measuring Diameter Of Cage.

8. Divide the dimension in half to get the radius. Make a note of radius dimension.
9. Use the following procedure to calculate the bearing preload (torque).

Pounds pulled x Radius (inches) +
lb.-in. preload x .113 + Nm preload
OR
Kilograms pulled x Radius (centimeters) +
kg-cm preload x .098 + Nm preload

Examples:
Reading from spring scale + 7.5 pounds (3.4 kg)
Diameter of bearing + 6.62 inches (16.8 cm)
Radius of bearing cage + 3.31 inches (8.4 cm)

7.5 lb. x 3.31 in. + 24.8 in.-lb. preload x .113
+ 2.8 Nm preload
OR
3.4 kg x 8.4 cm + 28.6 kg-cm preload x .098
+ 2.8 Nm preload

10. If the preload (torque) of pinion bearings is not within specifications, do the following procedure, then repeat steps 1 to 9. To increase preload, install a thinner bearing spacer. To decrease preload, install a thicker bearing spacer.
11. Check the bearing preload with the drive pinion and cage assembly installed in the carrier. Follow the procedures to adjust preload of pinion bearings, yoke or flange method.

Yoke or Flange Method

1. Install the input yoke or flange, nut and washer on the drive pinion. The yoke or flange must be against the outer bearing.

NOTE: If the fit between the yoke or flange splines and drive pinion splines are tight, use a press to install the yoke or flange (figure 2-46). If a press is not available, use the three-piece pilot tool for installation. See the procedure in earlier pages of this section.

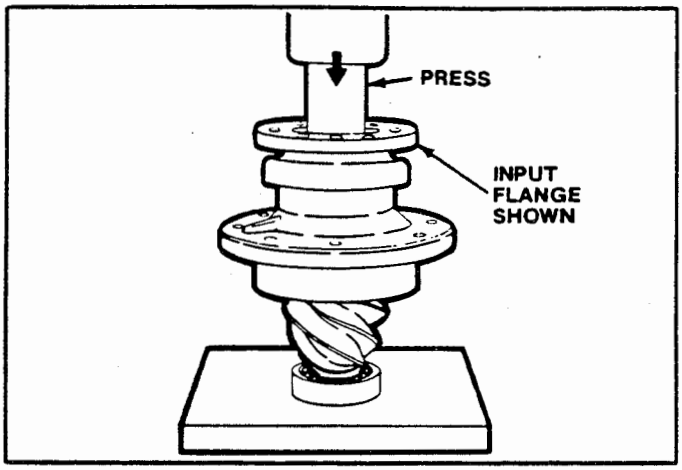


Figure 2-46. Pressing On Flange Or Yoke.

CAUTION: Do not install tight fit yokes or flanges on shafts using a hammer or mallet. A hammer or mallet will damage the yoke or flange.

2. Temporarily install the drive pinion and cage assembly in the carrier. Do not install shims under the bearing cage (Figure 2-47).
3. Install the bearing cage to carrier capscrews. Washers are not required at this time. Tighten the capscrews hand tight.
4. Fasten a yoke or flange bar to the input yoke or flange. The bar will hold the drive pinion in position when the nut is tightened (Figure 2-47).

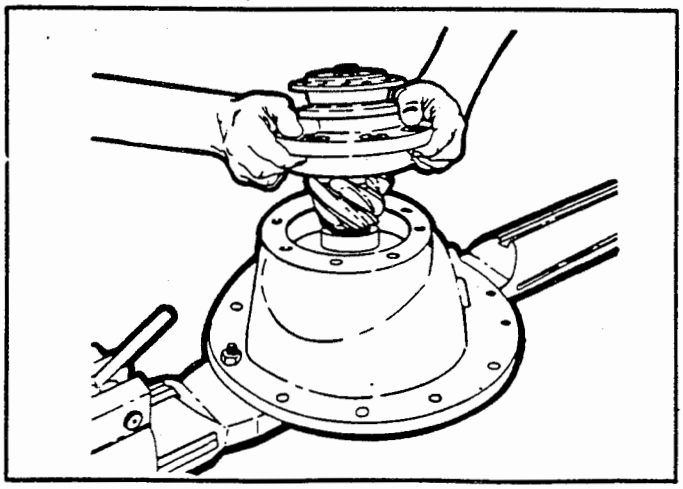


Figure 2-47. Placing Pinion And Cage Assembly In Carrier.

5. Tighten the nut on drive pinion to minimum 800 ft. lbs. (1,085 Nm), maximum 1,100 ft. lbs. (1,492 Nm) (Figure 2-48).

6. Remove the yoke or flange bar.

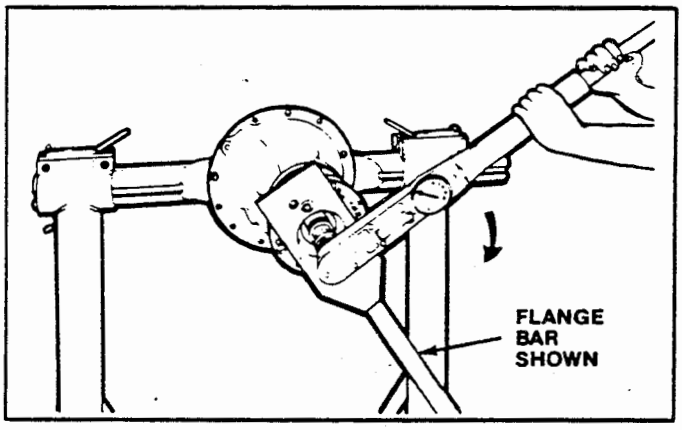


Figure 2-48. Torquing Drive Pinion Nut.

7. Attach a torque wrench on the drive pinion nut. Rotate the drive pinion and read the value indicated on torque wrench (Figure 2-49).

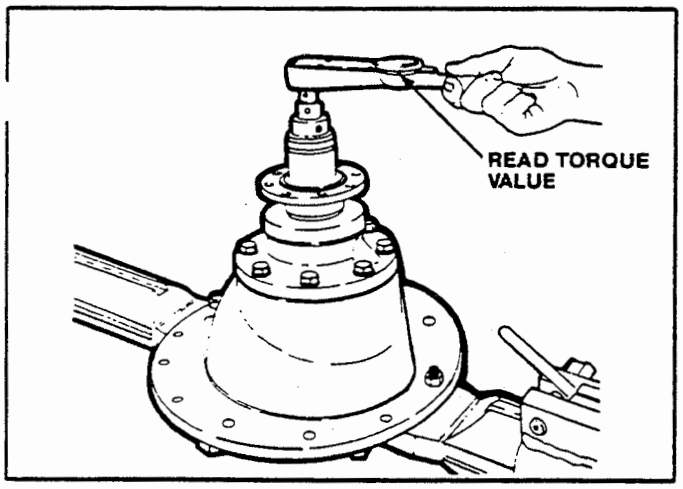


Figure 2-49. Reading Drive Pinion Torque.

NOTE: The preload (torque) of pinion bearings can be increased or decreased by tightening or loosening the pinion nut within specifications.

8. If the preload (torque) of pinion bearings is not within specifications, remove the pinion and cage assembly from carrier. Do the following procedure, then repeat steps 1 to 7. To increase preload, install a thinner bearing spacer. To decrease preload, install a thicker bearing spacer.

After adjusting preload of pinion bearings, remove the drive pinion and bearing cage from carrier. Follow steps 1 to 4 of procedure for removing pinion and cage from carrier.

If the carrier has a cover and seal assembly over the bearing cage, install a new seal into cover as follows.

1. Apply Lubriplate or grease used for wheel bearings to the seal lips and cavities between lips.

2. Apply a sealing compound on the outer diameter of seal.

3. Put the cover in a press, large diameter toward the top.

4. Support the cover under the small diameter opening with metal or wood blocks (Figure 2-50).

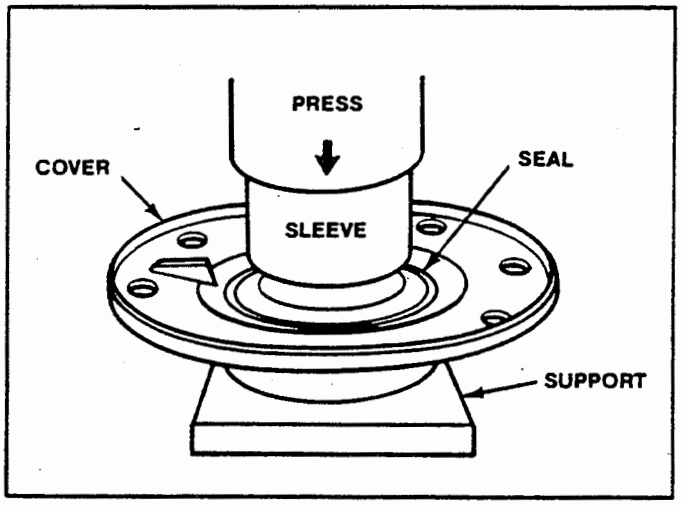


Figure 2-50. Pressing Seal Into Cover.

5. Press the seal into cover until seal is flat against the bottom of bore. Use a sleeve or seal driver of the correct size that fits against the metal retainer of seal (Figure 2-50).

NOTE: If a press is not available, use a mallet and the sleeve or driver to install the seal (Figure 2-51).

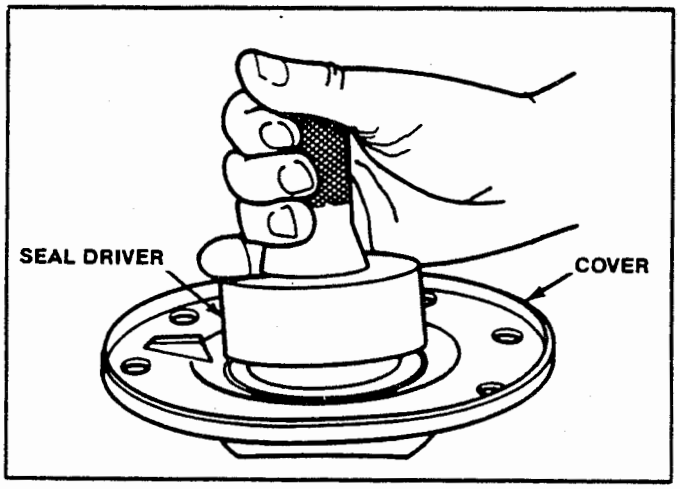


Figure 2-51. Installing Seal With Driver.

WARNING: Wear safe eye protection. Do not hig steel parts or tools with a steel hammer. Parts or tools can break and cause injury.

If the pinion seal mounts directly into the bearing cage, install a new triple-lip seal as follows.

1. Apply Lubriplate or grease used for wheel bearings to the seal lips and cavities between lips (Figure 2-51).

2. Apply axle lubricant to seal bore in bearing cage (Figure 2-52).

MC-9 MAINTENANCE MANUAL

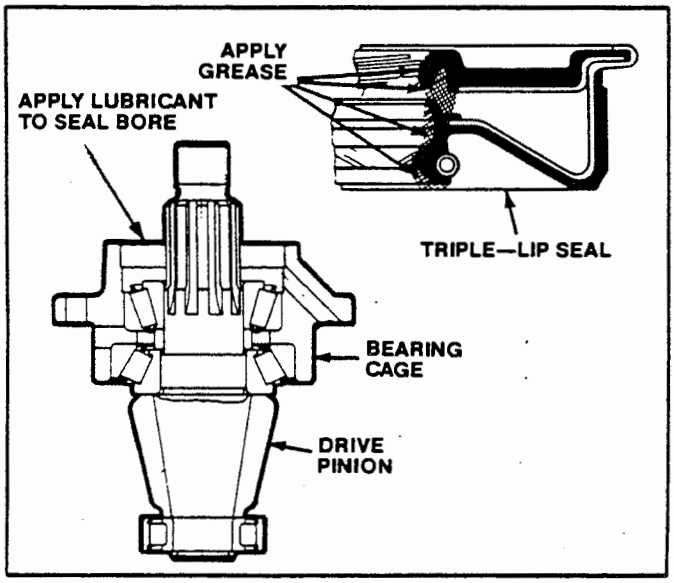


Figure 2-52. Installing Seal Into Bore.

3. Put the drive pinion and cage assembly in a press, seal bore toward the top.

4. Press the seal into bearing cage until flange of seal is flat against the top of bearing cage. Use a sleeve or seal driver of the correct size that fits against the metal flange of seal. The diameter of the sleeve or driver must be larger than the diameter of the flange (Figure 2-53).

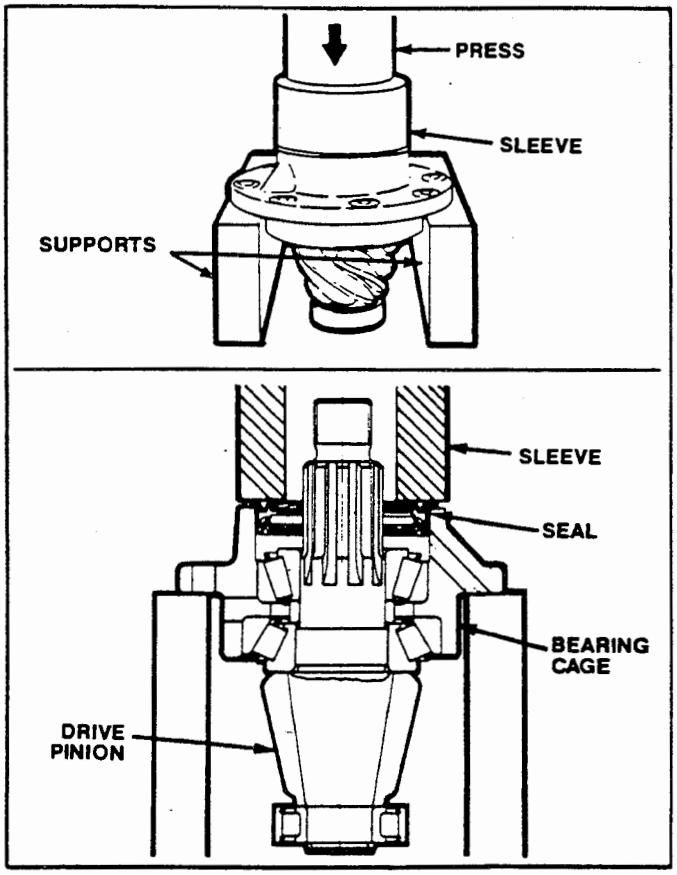


Figure 2-53. Pressing In Seal.

NOTE: If a press is not available, use a mallet and the sleeve or driver to install the seal (Figure 2-54).

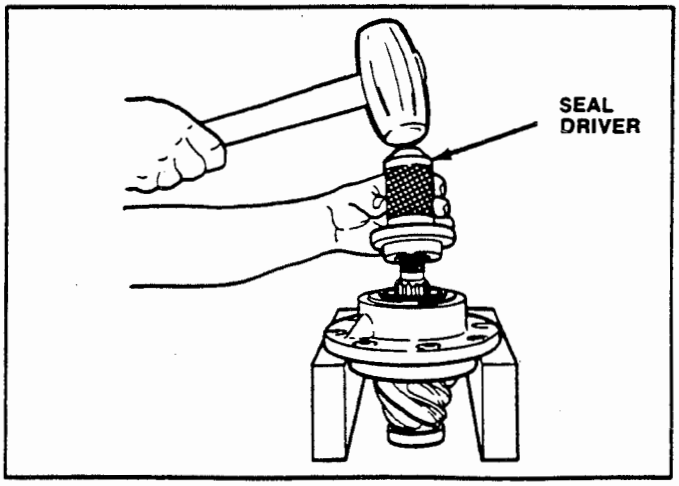


Figure 2-54. Putting In Seal With Driver.

WARNING: Wear eye protection. Do not hit steel parts or tools with a steel hammer. Parts or tools can break and cause injury.

5. After the triple-lip seal is installed, a gap of approximately .015 to .030 inch (.38 to .76 mm) between the flange and bearing cage is normal (Figure 2-55).

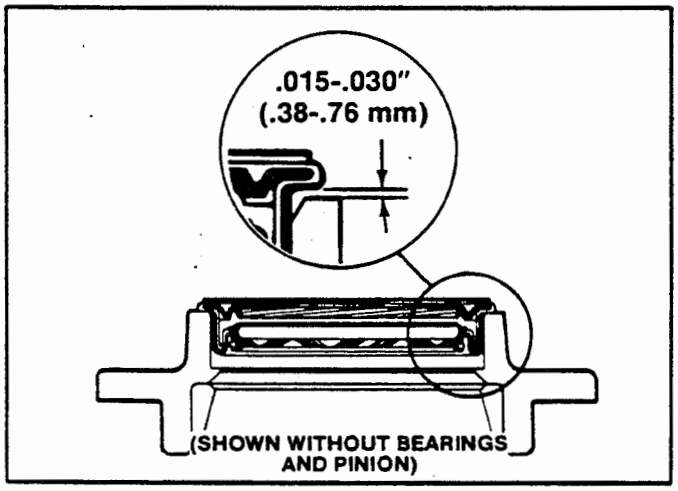


Figure 2-55. Checking Seal Gap.

Check the gap with a feeler gauge at several points around the seal. The gap must be within .015 to .030 inch (.38 to .76 mm). The difference between the largest and smallest gap measurement must not exceed .010 inch.

INSTALLING THE DRIVE PINION, BEARING CAGE AND SHIM PACK INTO THE CARRIER

NOTE: If a new drive pinion and ring gear set is installed, or if the depth of the drive pinion has to be adjusted, calculate the thickness of the shim pack. See the procedure to Adjust Thickness Of Shim Pack For The Pinion Cage in later pages of this section.

MC-9 MAINTENANCE MANUAL

1. Install the correct shim pack between the bearing cage and carrier (Figure 2-56).

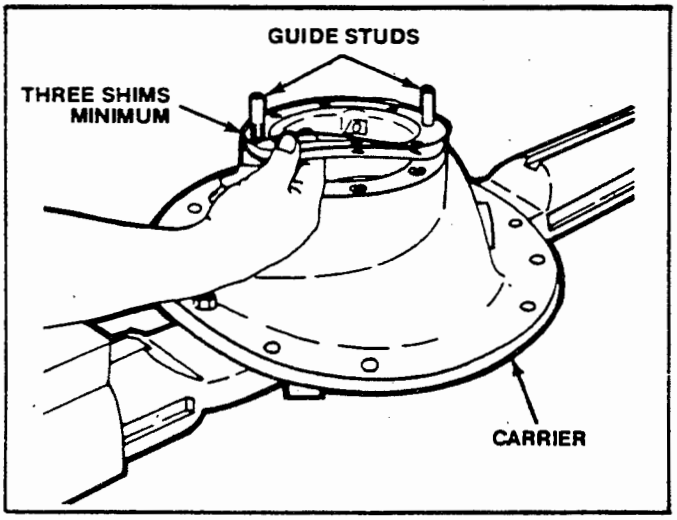


Figure 2-56. Installing Shims.

2. Align the oil slots in the shims with oil slots in the bearing cage and carrier. The use of guide studs will help align the shims (Figure 2-56).

NOTE: Use a minimum of three shims in a pack. If the pack is made from different thickness shims, install the thinnest shims on both sides of the pack for maximum sealing.

3. Install the drive pinion and bearing cage into the carrier. If necessary, use a rubber, plastic or leather mallet to hit the assembly into position (Figure 2-57).

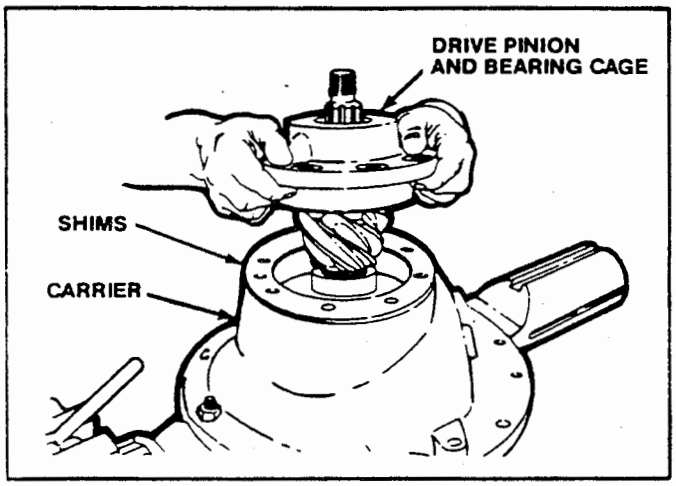


Figure 2-57. Installing Drive Pinion And Cage.

WARNING: Wear safe eye protection. Do not hit steel parts with a steel hammer. Parts can break and cause injury.

4. Align the oil slots in the cover and gasket with oil slot in the bearing cage.

5. Install the bearing cage to carrier capscrews and washers. Tighten capscrews to correct torque value. See the torque chart later in this section (Figure 2-58).

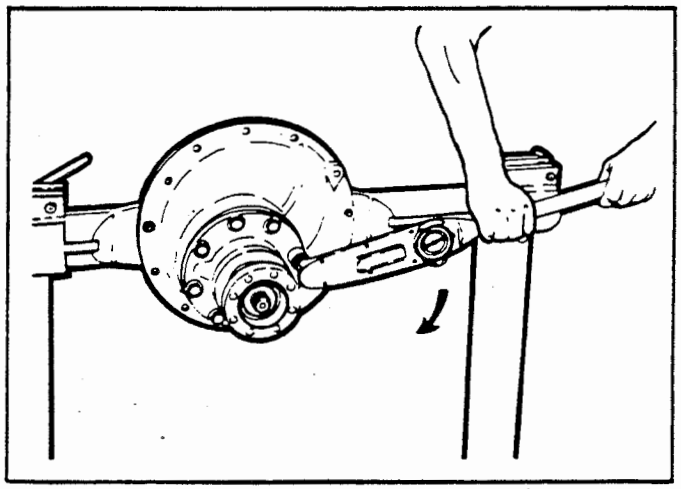


Figure 2-58. Torquing Cage Mounting Capscrews.

6. Install the input yoke or flange, nut and washer on the drive pinion. The yoke or flange must be against the outer bearing.

NOTE: If the fit between the yoke or flange splines and drive pinion splines is tight, use the three-piece pilot tool for installation. See the procedure in earlier pages of this section.

CAUTION: Do not install tight fit yokes or flanges on shafts using a hammer or mallet. A hammer or mallet will damage the yoke or flange.

7. Tighten the pinion nut to minimum 800 ft. lbs (1,085 Nm), maximum 1,100 ft. lbs. (1,492 Nm) (Figure 2-59).

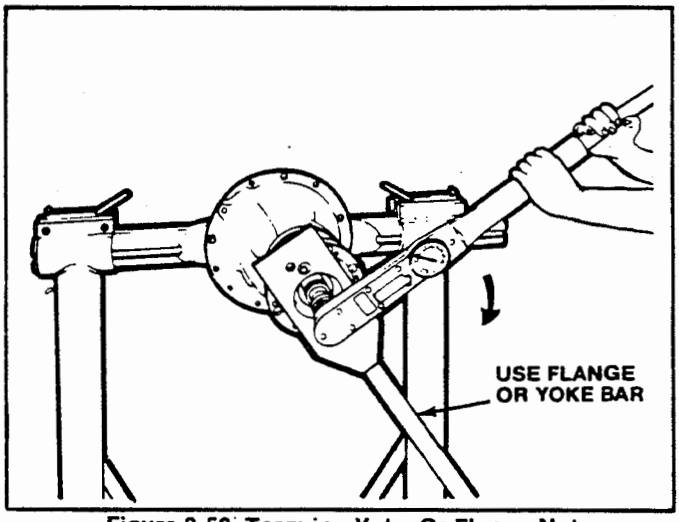


Figure 2-59. Torquing Yoke Or Flange Nut.

ADJUSTING THICKNESS OF SHIM PACK FOR THE PINION CAGE (DEPTH OF PINION)

NOTE: Use this procedure if a new drive pinion and ring gear set is installed, or if the depth of the drive pinion has to be adjusted (Figure 2-60).

MC-9 MAINTENANCE MANUAL

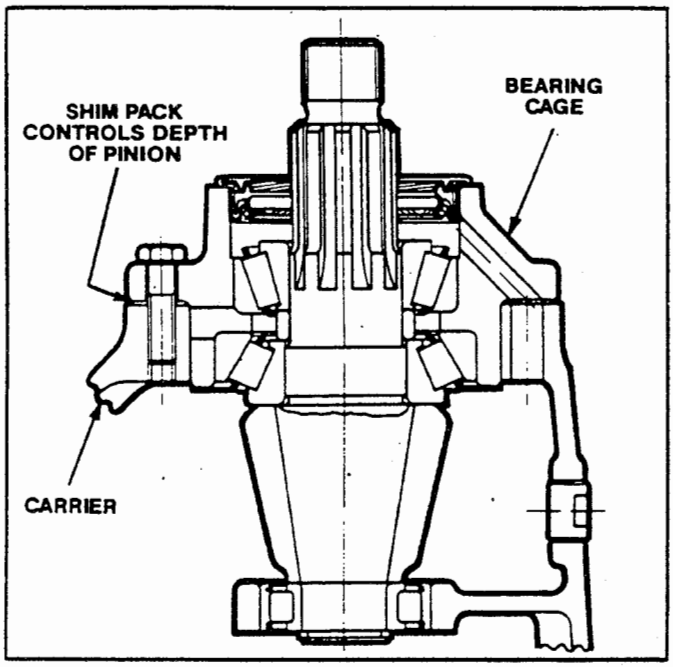


Figure 2-60. Shim Pack Adjustment.

1. Measure the thickness of the old shim pack that was removed from under the pinion cage with a micrometer. Record the measurement for later use (Figure 2-61).

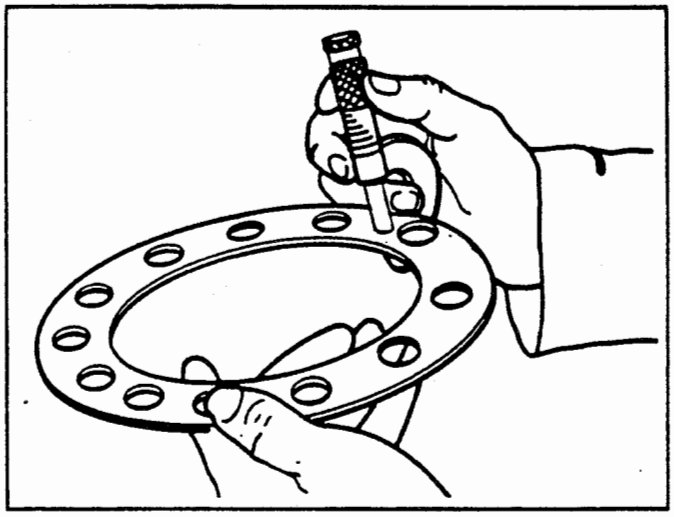


Figure 2-61. Measuring Thickness Of Old Shim Pack.

2. Look at the pinion cone ("PC") bariation number on the old drive pinion that is being replaced. See Gear Set Information, step 4 in earlier pages of this section for examples and locations of the number. Record the number for later use.

NOTE: The pinion cone number can be either 1,000ths of an inch or 100ths of a millimeter. See the following examples.

PC+3, PC-3, +3 or -3 equal .003 inch.
PC+.03, PC-.03, +.03 or -.03 equal .03 mm.

To change inches to millimeters, multiply inches by 25.40.
To change millimeters to inches, multiply millimeters by 0.039.

3. If the old pinion cone number is a plus (+), subtract the number from the old shim pack thickness that was measured in step 2.
4. If the old pinion cone number is a minus (-), add the number to the old shim pack thickness that was measured in step 2.

NOTE: The value calculated in step 3 or 4 is the thickness of the standard shim pack, without a variation.

5. Look at the pinion cone ("PC") variation number on the new drive pinion that will be installed. Record the number for later use.
6. If the new pinion cone number is a plus (+), add the number to the standard shim pack thickness that was calculated in step 3 or 4.
7. If the new pinion cone number is a minus (-), subtract the number from the standard shim pack thickness that was calculated in step 3 or 4.

NOTE: The value calculated in step 6 or 7 is the thickness of the new shim pack that will be installed. See the example in the following chart.

Examples:	Inches	mm
1. Old Shim Pack Thickness	.030	.76
Old PC Number, PC+2	- .002	- .05
Standard Shim Pack Thickness	.028	.71
New PC Number, PC+5	+ .005	+ .13
New Shim Pack Thickness	.033	.84
2. Old Shim Pack Thickness	.030	.76
Old PC Number, PC-2	+ .002	+ .05
Standard Shim Pack Thickness	.032	.81
New PC Number, PC+5	+ .005	+ .13
New Shim Pack Thickness	.037	.94
3. Old Shim Pack Thickness	.030	.76
Old PC Number, PC+2	- .002	- .05
Standard Shim Pack Thickness	.028	.71
New PC Number, PC-5	- .005	- .13
New Shim Pack Thickness	.023	.58
4. Old Shim Pack Thickness	.030	.76
Old PC Number, PC-2	+ .002	+ .05
Standard Shim Pack Thickness	.032	.81
New PC Number, PC-5	- .005	- .13
New Shim Pack Thickness	.027	.68

IMPORTANT: Remember that the drive pinions and ring gears must be replaced as matched sets.

8. Install the drive pinion, bearing cage and new shim pack into the carrier. See the procedure earlier in this section.

ASSEMBLING THE MAIN DIFFERENTIAL AND RING GEAR ASSEMBLY

CAUTION: Do not press a cold ring gear on the flange case half. A cold ring gear will damage the case half because of the tight fit. Metal particles between the parts will cause gear runout that exceeds the Rockwell specification of .008 inch (0.2 mm).

1. Expand the ring gear by heating the gear in a tank of water to a temperature of 160°F to 180°F (71°C to 82°C) for 10 to 15 minutes.

WARNING: Wear safe clothing and gloves that will protect you from injury when you touch the hot ring gear.

2. Safely lift the ring gear from the tank of water using a lifting tool.
3. Install the ring gear on the flange case half immediately after the gear is heated. If the ring gear does not fit easily on the case half, heat the gear again. Repeat step 1.
4. Align fastener holes of the ring gear and flange case half. Rotate the ring gear as needed.
5. Install the bolts, nuts and washers that hold the ring gear to the flange case half. Install the bolts from the gear side of the assembly. The bolt heads must be against the ring gear (Figure 2-62).

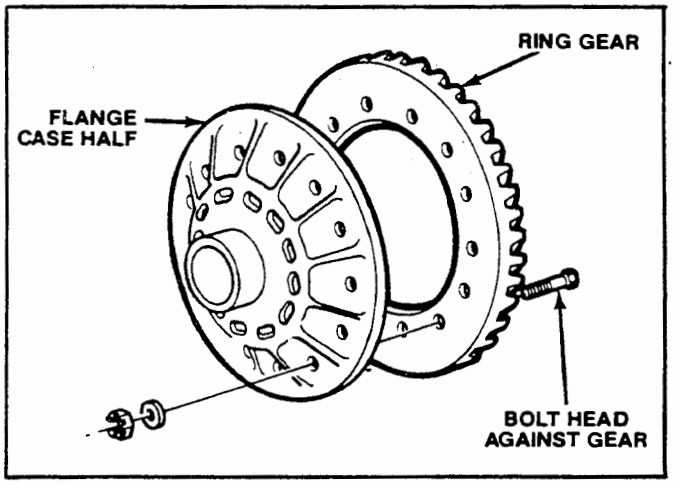


Figure 2-62. Installing Ring Gear Mounting Bolts.

6. Tighten the bolts and nuts to the correct torque value. See the torque chart later in this section.
7. When rivets are used to hold the ring gear to the flange case half, install the rivets as follows:

CAUTION: Do not heat rivets before installation. Use only cold rivets to fasten the ring gear correctly on the flange case half.

a. Install the correct size rivets in pairs opposite each other from the case half side of the assembly. The rivet heads **must** be against the flange case half (Figure 2-63).

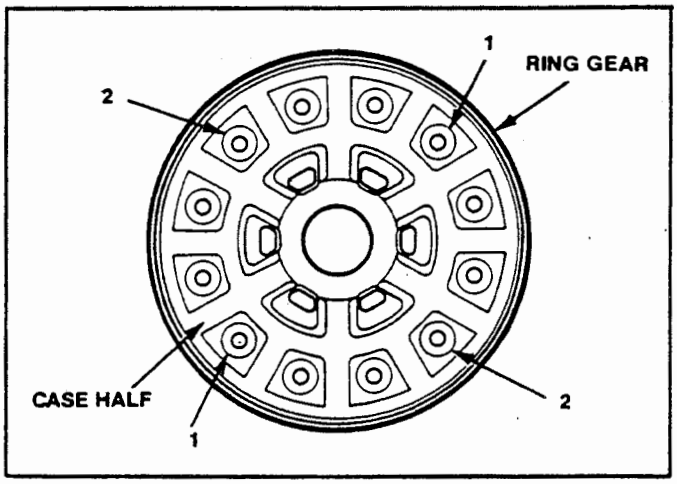


Figure 2-63. Installing Rivets.

b. Press the rivets into position from the ring gear side of the assembly. Use a riveter machine and apply the correct amount of pressure. See following chart for rivet pressures.

Diameter of Rivet Body	Press Pressure Needed to Install Rivets	
inch (mm)	pounds / tons	kilograms / metric tons
.438 (11.13)	44,000 / 22	19,958 / 20.0
.500 (12.70)	60,000 / 30	27,216 / 27.2
.563 (14.30)	72,000 / 36	32,659 / 32.7
.625 (15.88)	90,000 / 45	40,824 / 40.8

CAUTION: The pressure on rivets must held for approximately one minute so that the rivet body will fill the hole.

c. After the rivets are installed, check for gaps between the back surface of the ring gear and the case flange. Use a .003 inch (.08 mm) feeler gauge and check at four points around the assembly (Figure 2-64).

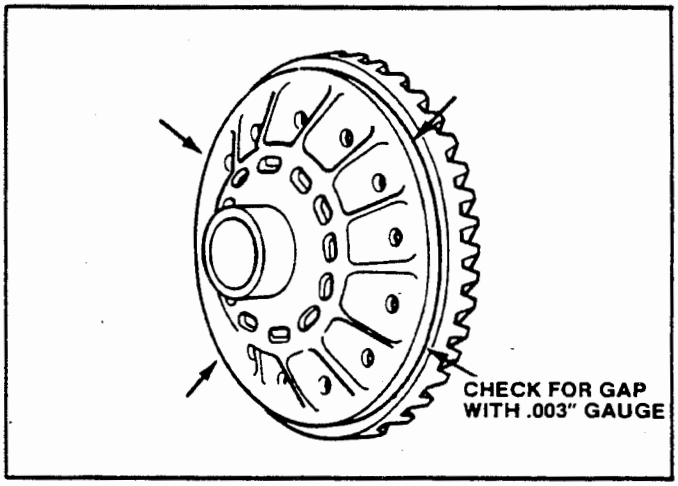


Figure 2-64. Checking Gap.

If the gauge fits more than one-half the distance between the outer diameter of the flange and the pilot diameter of the gear, remove the ring gear. See the procedure for rivet removal in earlier pages of this section and the following steps *d* and *e*. If the gap is less than .003 inch (.08 mm), continue by following step 8.

d. Check the flange case half and ring gear for the problem that causes the gap. Repair or replace parts.

e. After the parts are repaired or replaced, assemble the ring gear on the flange case half. Repeat steps *1* through *6* and steps *7a* through *7c* of the main differential and ring gear assembly procedure.

8. Install the bearing cones on both of the case halves. Use a press and sleeve of the correct size (Figure 2-65).

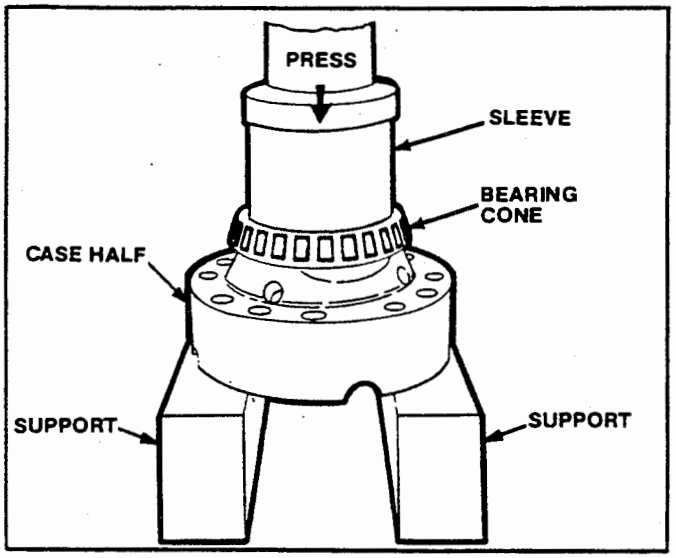


Figure 2-65. Installing Bearing Cones.

9. Apply axle lubricant on the inside surfaces of both case halves, spider (cross), thrust washers, side gears and differential pinions.

10. Put the flange case half on a bench, ring gear teeth toward top.

11. Install one thrust washer and side gear into the flange case half (Figure 2-66).

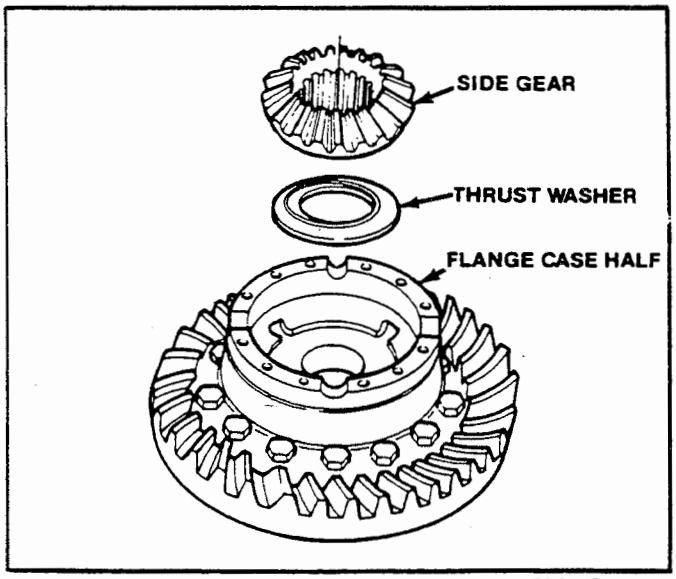


Figure 2-66. Installing Thrust Washer And Side Gear.

CAUTION: The side gears in some carrier models have hubs of different lengths. Install the correct length side gear into the flange case half.

12. Install the spider (cross), differential pinions and thrust washers into the flange case half (Figure 2-67).

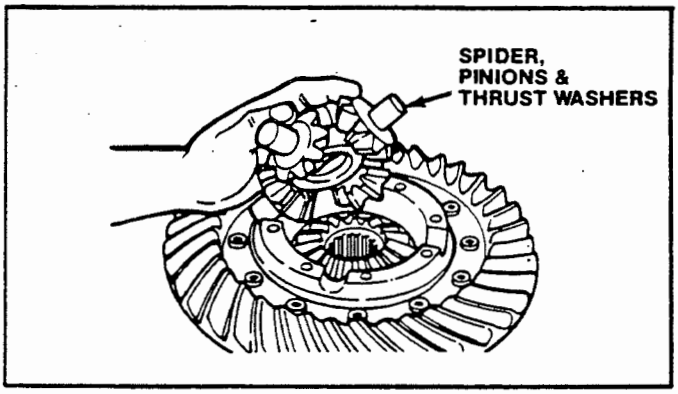


Figure 2-67. Installing Spider, Pinions And Thrust Washers.

13. Install the second side gear and thrust washer over spider and differential pinions (Figure 2-68).

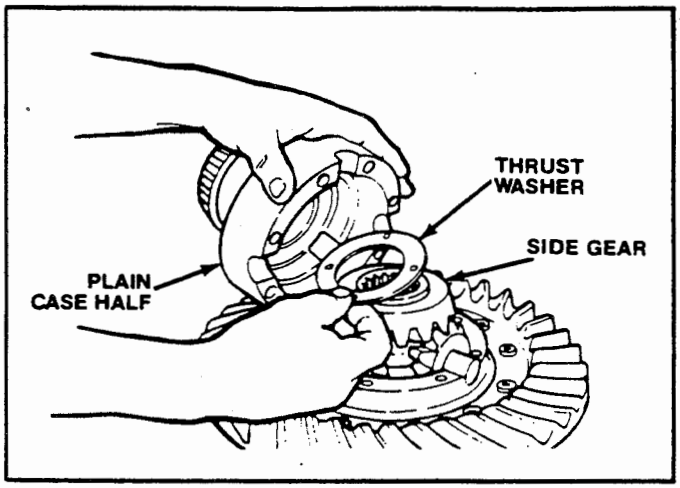


Figure 2-68. Installing Second Side Gear And Thrust Washer.

14. Put the plain half of the differential case over the flange half and gears. Rotate the plain half as needed to align the match marks (Figures 2-68 and 2-69).

15. Install Dri-Loc fasteners into the case halves. See the procedures in earlier part of this section and the following steps, a and b.

a. Install four capscrews and washers or bolts, nuts and washers into the case halves. The distance between the fasteners must be equal. Tighten the fasteners to the correct torque value in a pattern opposite each other (Figure 2-70). See torque chart in later pages of this section.

b. Install the other fasteners into the case halves. Tighten the fasteners to the correct torque value. See the torque chart later in this section.

MC-9 MAINTENANCE MANUAL

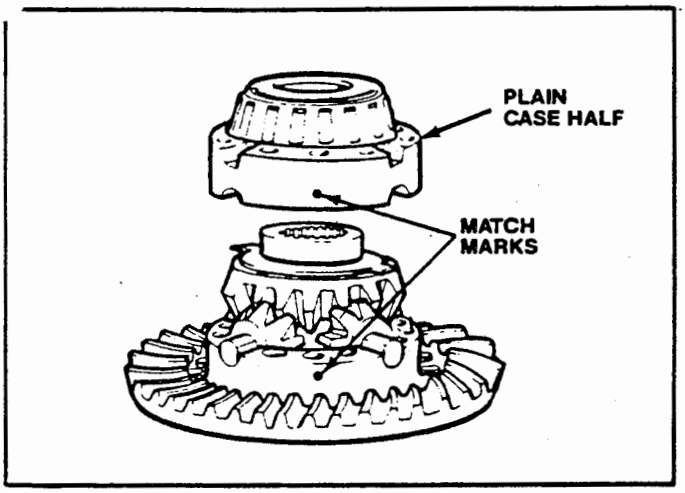


Figure 2-69. Aligning Match Marks.

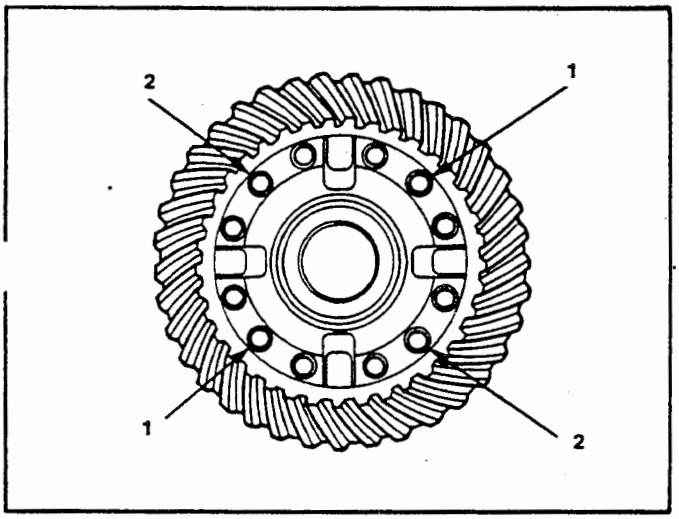


Figure 2-70. Installing Capscrews In Equally Spaced Pattern.

16. Check the rotating resistance of the differential gears. Use the following procedure.

Rotating Resistance Check of Differential Gears

Specification:
50 lb.-ft. (67.8 Nm) torque maximum applied to one side gear.

NOTE: Make a tool for checking the rotating resistance of the differential gears. the tool can be made from an axle shaft that matches the spline size of the differential side gear. See Figure 2-71.

a. Install soft metal covers over vise jaws to protect the ring gear (Figure 2-72).

b. Put the differential and ring gear assembly in the vise.

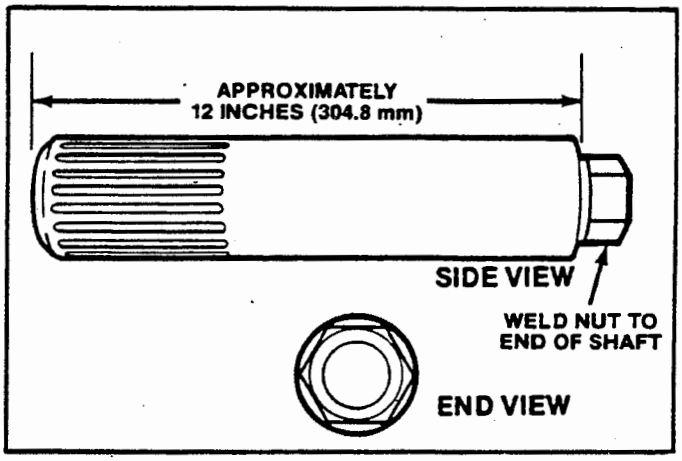


Figure 2-71. Rolling Resistance Check Tool.

c. Install the tool into the differential until the splines of the tool and one side gear are engaged (Figure 2-72).

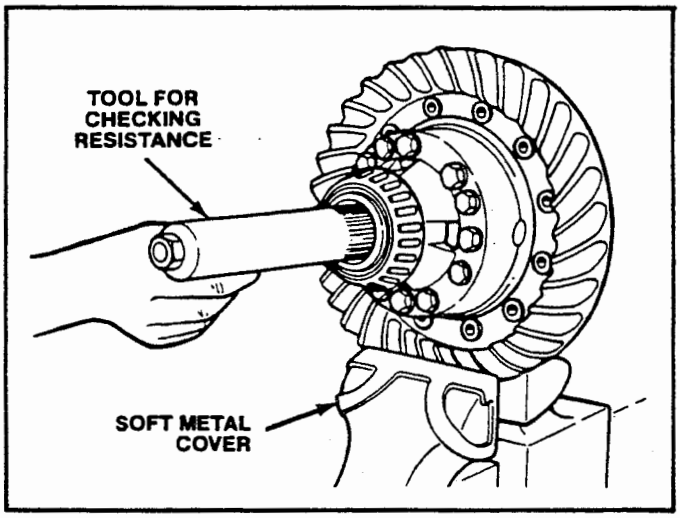


Figure 2-72. Installing Rolling Resistance Checking Tool.

d. Attach a torque wrench to the nut of the tool and rotate the differential gears. As the differential gears rotate, read the value indicated on the torque wrench (Figure 2-73).

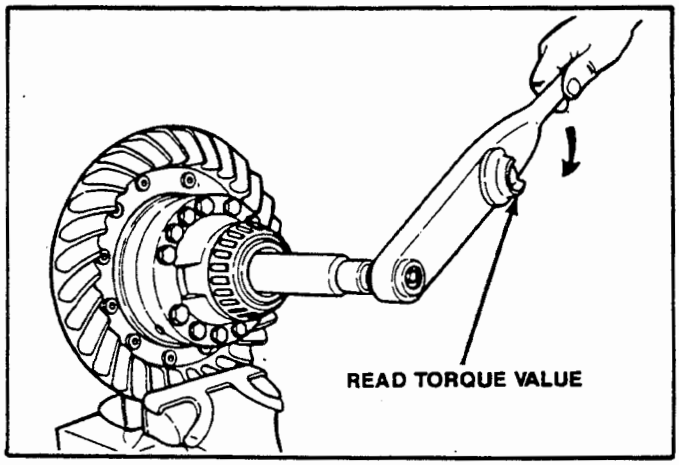


Figure 2-73. Reading Rolling Resistance Torque.

e. If the torque value exceeds the specification, disassemble the differential gears from the case halves.

f. Check the case halves, spider, gears and thrust washers for the problem that causes the torque value to exceed the specification. Repair or replace parts.

17. After the parts are repaired or replaced, assemble the parts and repeat steps *a* to *f*.

Installing the Differential and Ring Gear Assembly

1. Clean and dry the bearing cups and bores of the carrier legs and bearing caps.

2. Apply axle lubricant on the inner diameter of the bearing cups and on both bearing cones that are assembled on the case halves.

3. Apply Rockwell Adhesive in the bearing bores of the carrier legs and bearing caps. See the procedure in earlier pages of this section.

4. Install the bearing cups over the bearing cones that are assembled on the case halves (Figure 2-74).

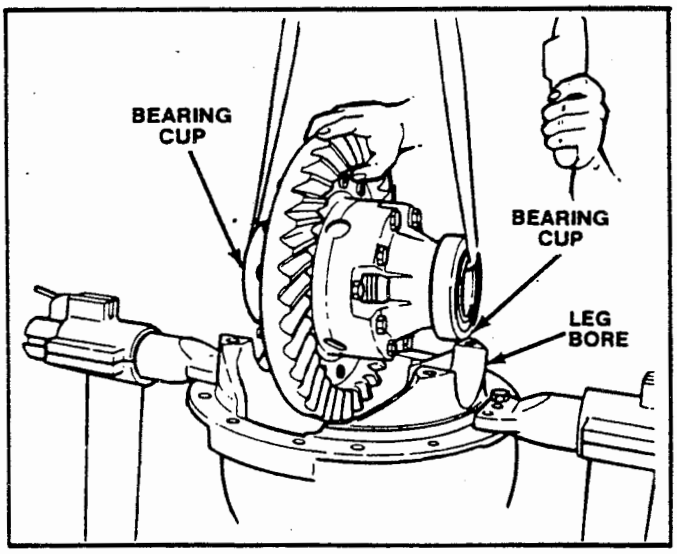


Figure 2-74. Installing Bearing Cups.

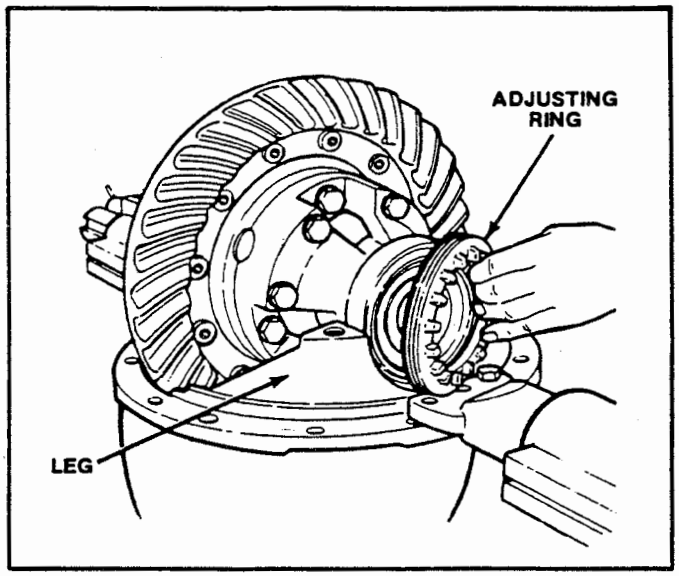


Figure 2-75. Installing Bearing Adjusting Rings.

5. Safely lift the differential and ring gear assembly and install into the carrier. The bearing cups must be flat against the bore between the carrier legs (Figure 2-74).

6. Install both of the bearing adjusting rings into position between the carrier legs. Turn each adjusting ring hand tight against the bearing cup (Figure 2-75).

7. Install the bearing caps over the bearings and adjusting rings in the correct location as marked before removal (Figure 2-76).

WARNING: Wear safe eye protection. Do not hit steel parts with a steel hammer. Parts can break and cause injury.

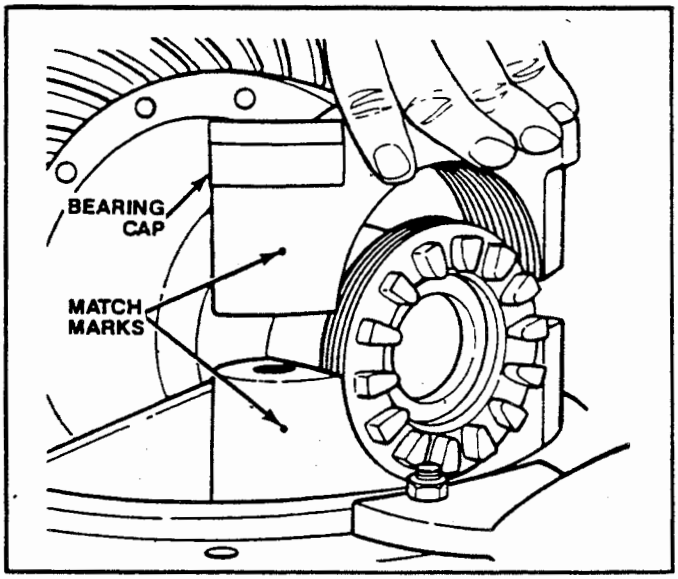


Figure 2-76. Installing Bearing Caps.

8. Hit each bearing cap into position with a light leather, plastic or rubber mallet. The caps must fit easily against the bearings, adjusting rings and carrier. Do not force the bearing caps into position.

CAUTION: If bearing caps are not installed in correct locations, the bores and threads in caps will not match the carrier. Problems assembling the caps on the carrier and damage to parts can occur. Do not force the bearing caps into position.

9. If bearing caps do not correctly fit into position, check the alignment of match marks between caps and carrier. Remove the caps and repeat steps *6* to *8*.

10. Install the capscrews and washers that hold bearing caps to the carrier. Tighten the capscrews by hand four to six turns, then tighten the capscrews to the correct torque value. See the torque chart on later page of this section.

NOTE: Do not install the cotter keys, pins or lock plates that hold the bearing adjusting rings in position. Continue by adjusting the preload of differential bearings, adjust backlash of the hypoid gear and check tooth contact patterns.

MC-9 MAINTENANCE MANUAL

ADJUSTING PRELOAD OF DIFFERENTIAL BEARINGS

Specifications:
Preload of differential bearings - 15 to 35 lb.-in. (1.7 to 3.9 Nm) torque.

1. Attach a dial indicator on the mounting flange of the carrier.
2. Adjust the dial indicator so that the plunger or pointer is against the back surface of the ring gear (Figure 2-77).

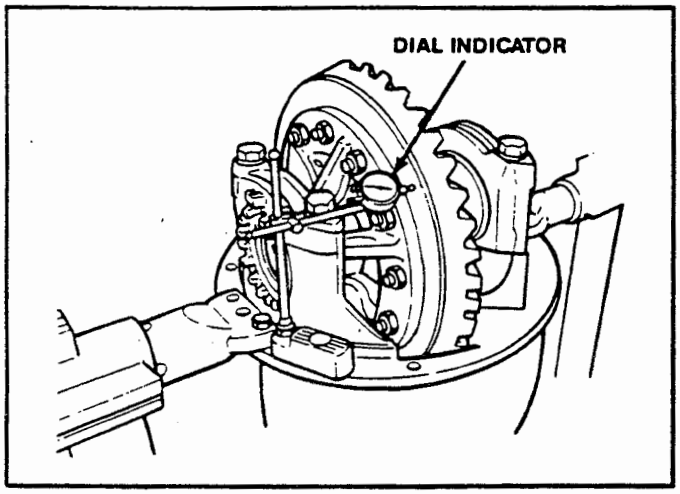


Figure 2-77. Positioning Of Dial Indicator.

CAUTION: When turning the adjusting rings, always use a tool that engages two or more opposite notches in the ring. A "T" bar wrench can be used for this purpose. If the tool does not correctly fit into the notches, damage to the lugs will occur (Figure 2-78).

3. Loosen the bearing adjusting ring that is opposite the ring gear so that a small amount of end play shows on the dial indicator (Figure 2-78). Move the differential and ring gear to the left and right with pry bars while reading the dial indicator. Use the following step *a* or *b*.

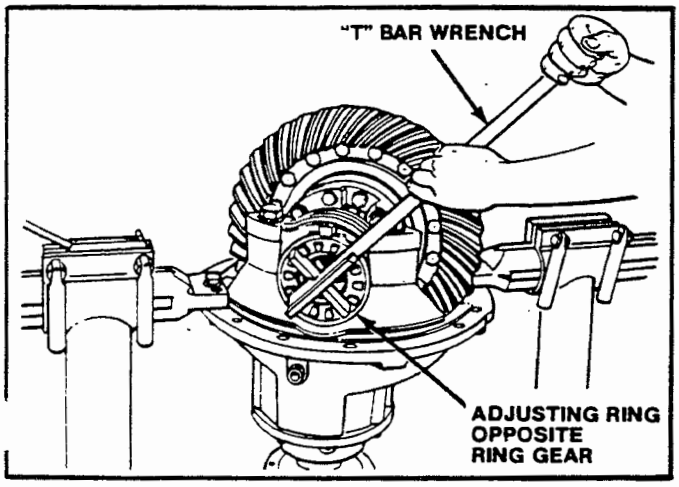


Figure 2-78. Loosening Bearing Adjusting Ring.

a. Use two pry bars that fit between the bearing adjusting rings and ends of the differential case. The pry bars **must not** touch the differential bearings (Figure 2-79).

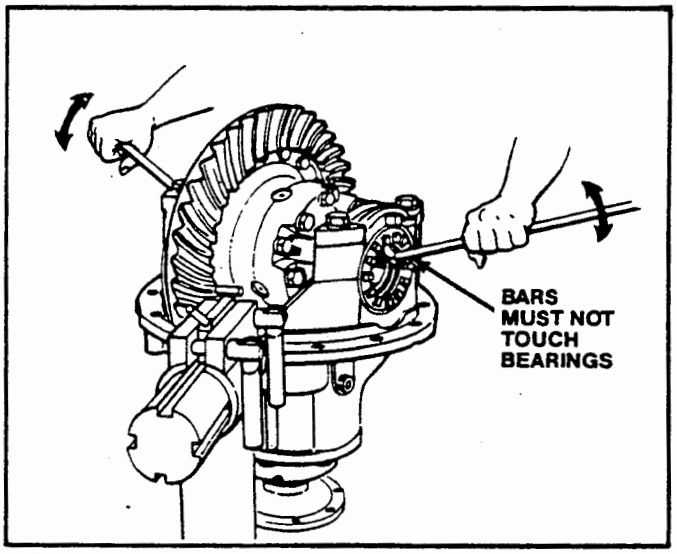


Figure 2-79. Placing Pry Bars At Bearing Adjusting Rings.

b. Use two pry bars between the differential case or ring gear and the carrier at locations other than described in step a. The pry bars **must not** touch the differential bearings (Figure 2-80).

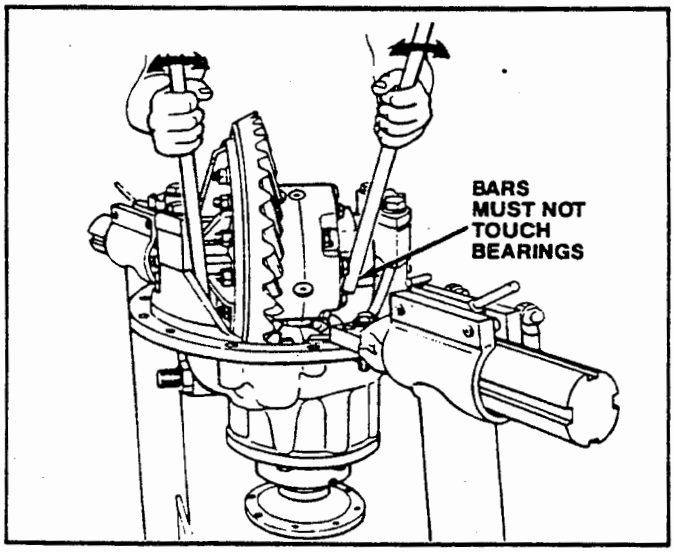


Figure 2-80. Placing Pry Bars (Alternate Locations).

4. Tighten the same bearing adjusting ring so that no end play shows on the dial indicator. Move the differential and ring gear to the left and right as needed. Repeat step *a* or *b*.
5. Tighten each bearing adjusting ring one notch from the zero end play measured in step 4.
6. Continue by checking runout of the ring gear.

CHECKING RUNOUT OF RING GEAR

1. Attach a dial indicator on the mounting flange of the carrier (Figure 2-81).

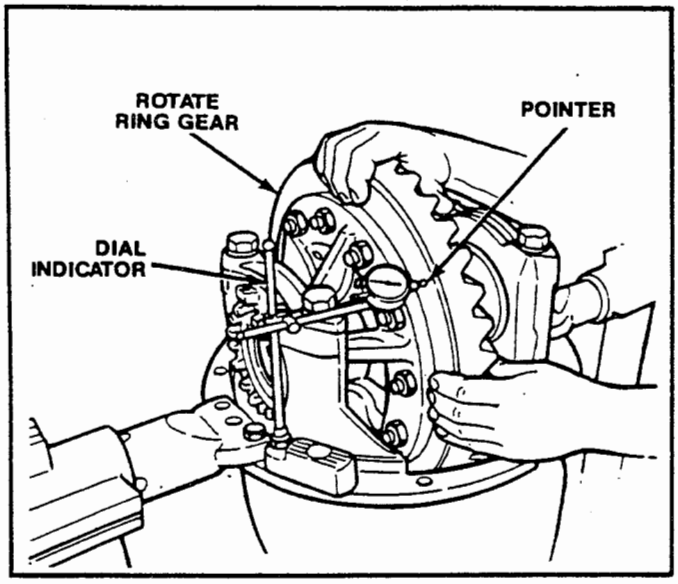


Figure 2-81. Checking Ring Gear Runout.

2. Adjust the dial indicator so that the plunger or pointer is against the back surface of the ring gear.
3. Adjust the dial of the indicator to zero (0).
4. Rotate the differential and ring gear while you read the dial indicator. The runout of the ring gear must not exceed .008 inch (.20 mm) (Figure 2-81). If runout of the ring gear exceeds specifications, remove the differential and ring gear assembly from the carrier. See the disassembly procedure in earlier pages of this section and the following steps *5* and *6*.
5. Check the differential parts including the carrier for the problem that causes the runout of gear to exceed specifications. Repair or replace parts.
6. After the parts are repaired or replaced, install the differential and ring gear into the carrier. See the procedure in preceding pages of this section.
7. Repeat preload adjustment of differential bearings.

ADJUSTING BACKLASH OF THE RING GEAR

Measure the outer diameter of ring gear for approximate pitch diameter (Figure 2-82).

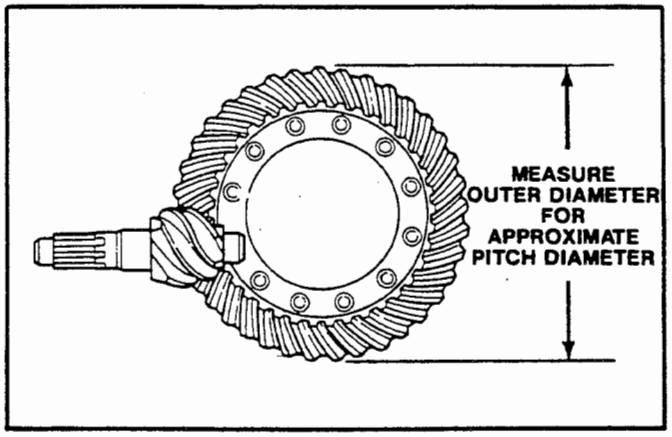


Figure 2-82. Determining Approximate Pitch Diameter.

Specifications:

Range of backlash setting — .008 to .018 inch (.20 to .46 mm).
Backlash setting for new gear sets — .012 inch (.30 mm).

If the old gear set is installed, adjust the backlash to the setting that was measured before the carrier was disassembled.

If a new gear set is installed, adjust the backlash to the correct specificadtion for new gear sets.

During the check of tooth contact patterns, the backlash can be adjusted within specification limits, if needed, to change the location of the pattern.

1. Attach a dial indicator on the mounting flange of the carrier (Figure 2-83).
2. Adjust the dial indicator so that the plunger or pointer is against the tooth surface (Figure 2-83).
3. Adjust the dial of the indicator to zero (0).
4. Hold the drive pinion in position.

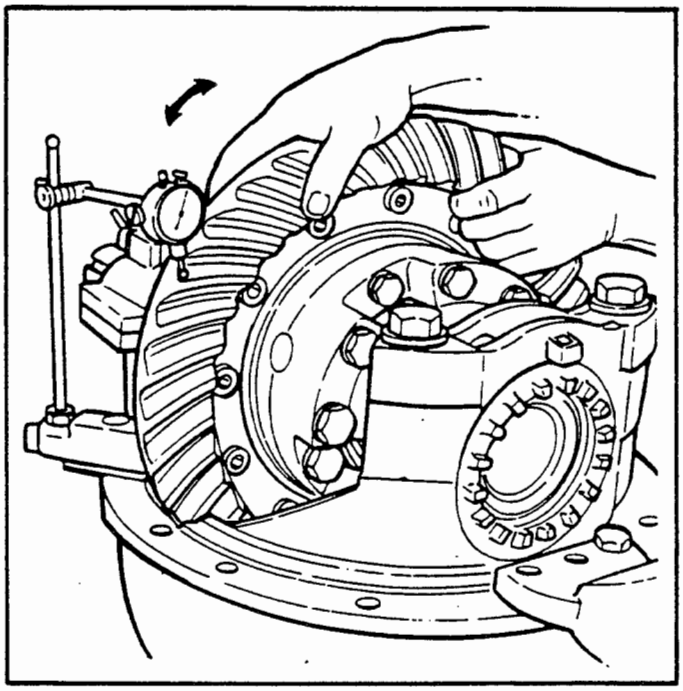


Figure 2-83. Attaching Dial Indicator.

5. While you read the dial indicator, rotate the differential and ring gear a small amount in both directions, against teeth of the drive pinion. If the backlash reading is within specification, continue by checking tooth contact patterns. If the backlash reading is not within specifications, adjust backlash as needed. Continue by following steps 6 and 7.

NOTE: Backlash is increased by moving the ring gear away from the drive pinion (Figure 2-84). Backlash is decreased by moving the ring gear toward the drive pinion (Figure 2-85).

6. Loosen one bearing adjusting ring one notch, then tighten the opposite ring the same amount (see Figures 2-84 and 2-85).

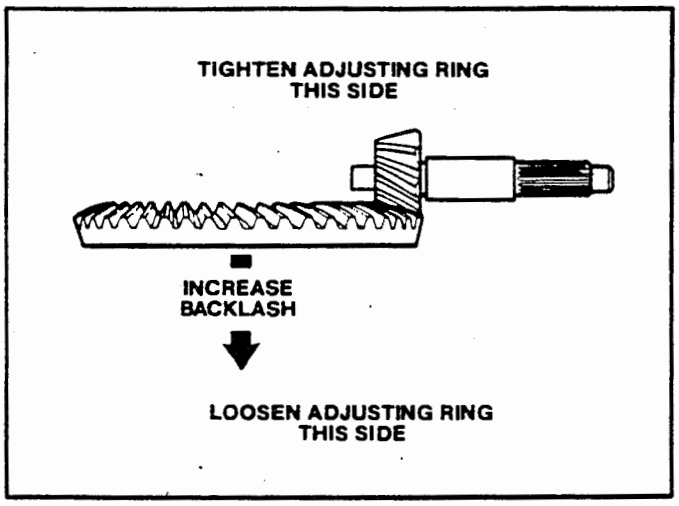


Figure 2-84. Adjusting For Increased Backlash.

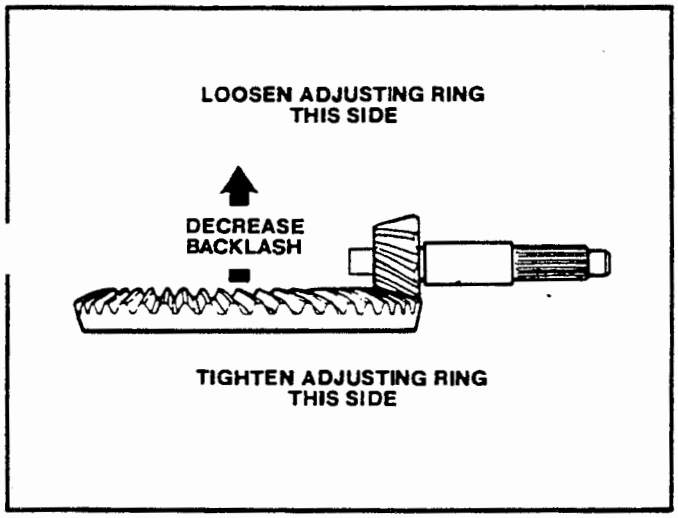


Figure 2-85. Adjusting For Decreased Backlash.

NOTE: When adjusting backlash, move the ring gear only. Do not move the drive pinion.

7. Repeat steps 2 to 6 until the backlash is within specifications.

CHECKING TOOTH CONTACT PATTERNS OF THE GEAR SET

GENERAL INFORMATION

The carrier has a conventional hypoid gear set.

In the following procedures, movement of the contact pattern in the length of the tooth is indicated as toward the "heel" or "toe" of the ring gear (Figure 2-86).

Always check tooth contact patterns on the drive side of the gear teeth (Figure 2-87).

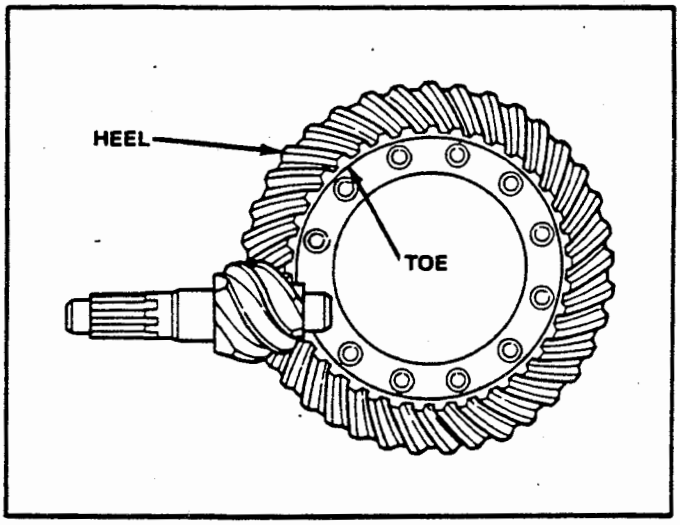


Figure 2-86. Hypoid Gear Heel And Toe Locations.

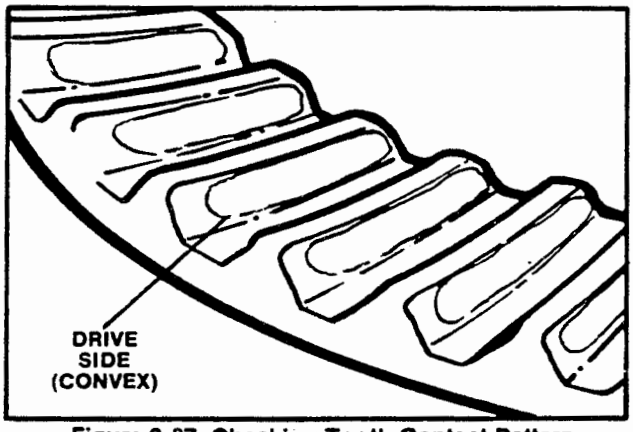


Figure 2-87. Checking Tooth Contact Pattern.

TOOTH CONTACT PATTERNS OF CONVENTIONAL HYPOID GEAR SETS

1. Adjust the backlash of a new gear set to .012 inch (.30 mm). Adjust the backlash of an old gear set to the setting that was measured before the carrier was disassembled. See the procedure on previous pages.

2. Apply a marking compound, such as oiled red lead, to approximately 12 gear teeth of the ring gear. Rotate the ring gear so that the 12 gear teeth are next to the drive pinion (Figure 2-88).

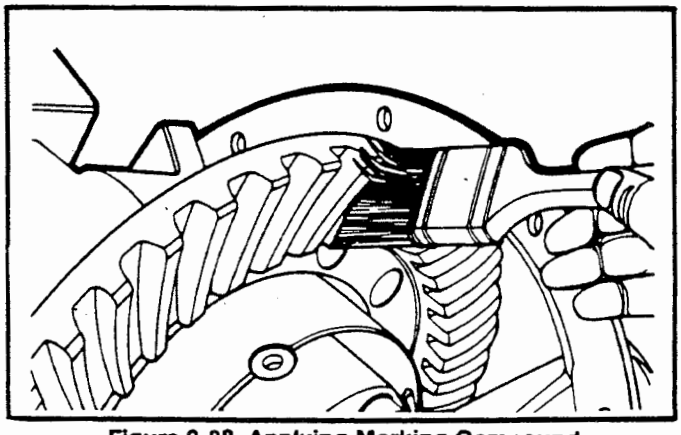


Figure 2-88. Applying Marking Compound.

3. Rotate ring gear forward and backward so that the 12 gear teeth go past the drive pinion six times to get the contact patterns. Repeat if needed to get a clearer pattern.

4. Look at the contact patterns on the ring gear teeth. Compare the patterns to Figures 2-89, 2-90 and 2-91.

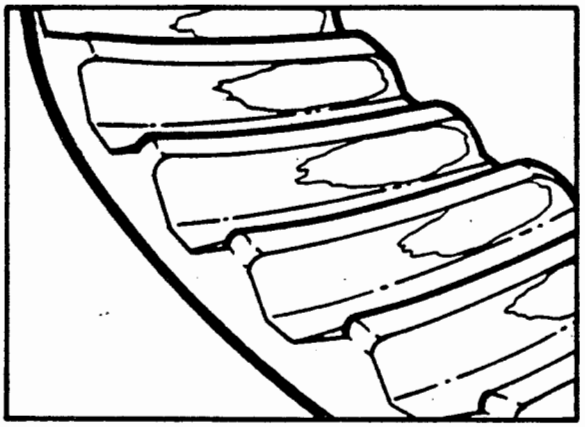


Figure 2-89. Good Hand Rolled Pattern.

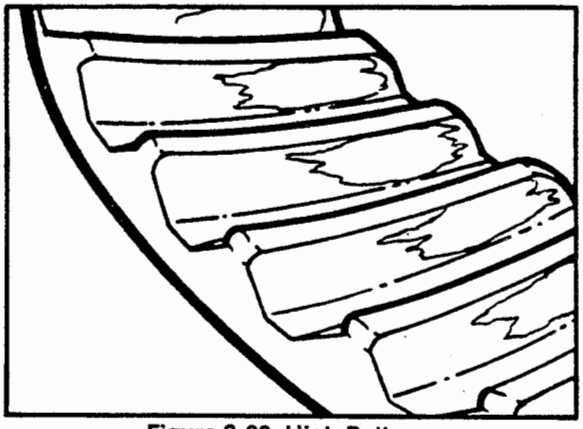


Figure 2-90. High Pattern.



Figure 2-91. Low Pattern.

The Location of Good Hand-Rolled Contact Patterns

For new gear sets, the location of good hand-rolled tooth contact patterns will be toward the toe of the gear tooth and in the center between the top and bottom of the tooth (see Figure 2-89).

When the carrier is being operated, a good pattern will extend approximately the full length of the gear tooth. The top of the pattern will be near the top of the gear tooth (see Figure 2-92).

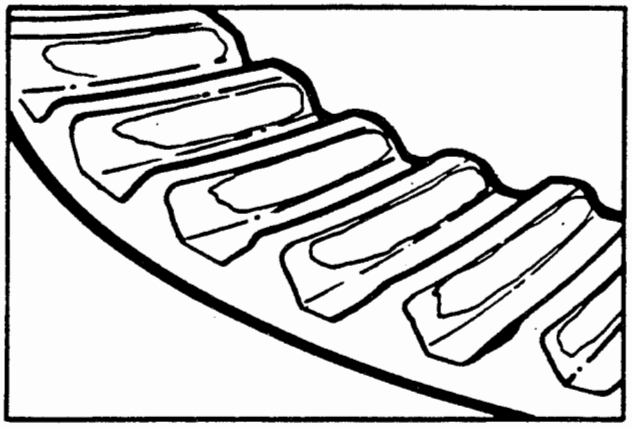


Figure 2-92. Good Pattern In Operation.

The location of a good hand-rolled contact pattern for an old gear set must match the wear pattern in the ring gear. The contact pattern will be smaller in area than the wear pattern.

If the contact patterns require adjustment, continue by following step 5 to move the contact patterns between the top and bottom of the gear teeth. If the contact patterns are in the center of the gear teeth, continue by following step 6.

5. Change the thickness of the shim pack under bearing cage to move the contact patterns between the top and bottom of the gear teeth. Use the following procedure.

NOTE: A high contact pattern indicates that the drive pinion was not installed deep enough into the carrier. A low contact pattern indicates that the drive pinion was installed too deep in the carrier.

a. Remove the drive pinion and bearing cage from the carrier.. See the procedure on previous pages.

b. To correct a high contact pattern (Figure 2-90), decrease the thickness of the shim pack under the bearing cage. When the thickness of the shim pack is decreased, the drive

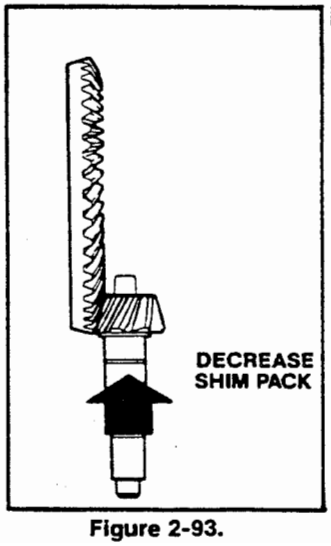


Figure 2-93.

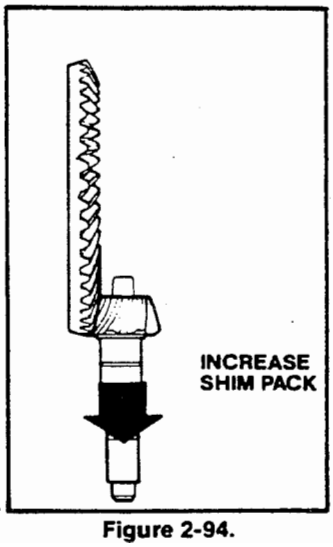


Figure 2-94.

pinion will move toward the ring gear (Figure 2-93). To correct a low contact pattern (Figure 2-91), increase the thickness of shim pack under the bearing cage. When the thickness of the shim pack is increased, the drive pinion will move away from the ring gear (Figure 2-94).

c. Install the drive pinion; bearing cage and shims into the carrier. See the procedure on previous pages.

d. Repeat steps 2 to 5 until the contact patterns are in the center between the top and ;bottom of the gear teeth.

6. Adjust backlash of the ring gear within specification range to move the contact patterns to the correct location in the length of the gear teth. See the procedure on previous pages.

a. Decrease backlash to move the contact patterns toward the toe of the ring gear teeth (Figure 2-95).

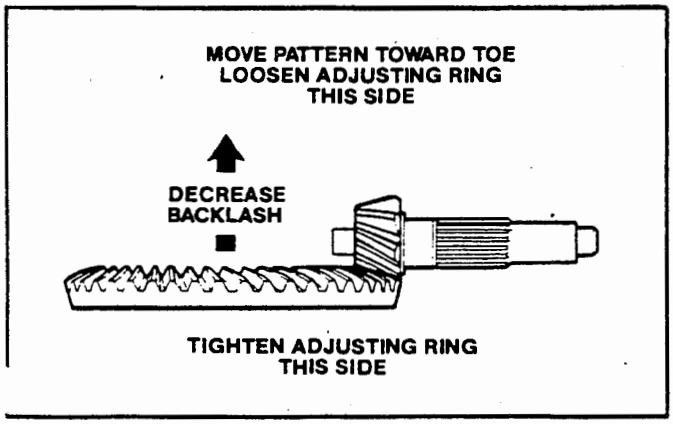


Figure 2-95. Moving Contact Pattern Toward Top Of Ring Gear Teeth.

b. Increase backlash to move the contact patterns toward the heel of the ring gear teeth (Figure 2-96).

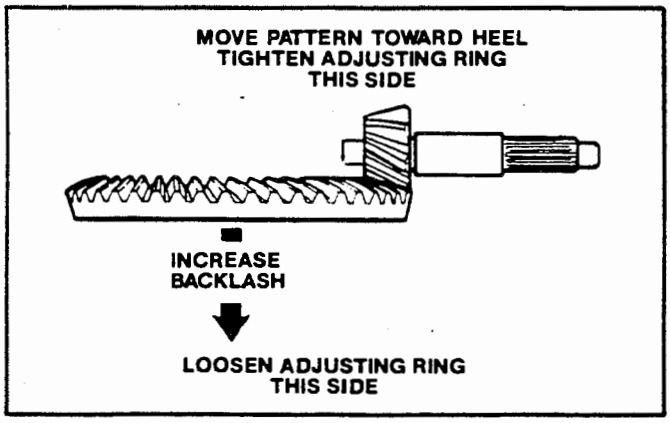


Figure 2-96. Moving Contact Pattern Toward Heel Of Ring Gear Teeth.

c. Repeat steps 2 to 4 and 6 until the contact patterns are at the correct location in the length of the gear teeth.

7. Install cotter keys, pins or lock plates that hold the two bearing adjusting rings in position. Use the following procedures.

a. Cotter Keys - Install cotter keys between lugs of the adjusting ring and through the boss of the bearing cap. Bend the two ends of the cotter key around the boss (Figure 2-97).

b. Pins - Install pin through boss of the bearing cap until the pin is between lugs of the adjusting ring. Use a drift and hammer to install the pin (Figure 2-97).

c. Lock Plates - Install lock plate on bearing cap so that the tab is between lugs of the adjusting ring. Install the two capscrews that hold the lock plate to the bearing cap. Tighten the capscrews to correct torque value. See the torque chart later in this section (Figure 2-97).

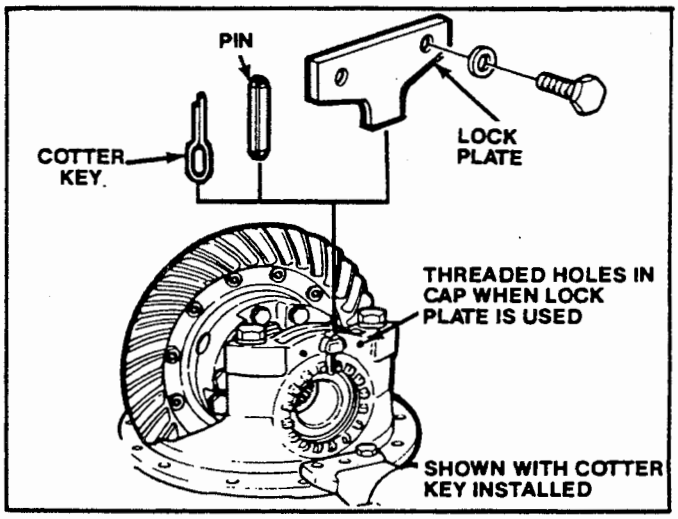


Figure 2-97. Fastening Bearing Adjusting Rings.

INSTALLING AND ADJUSTING THE THRUST SCREW

Specification:
Clearance between thrust screw and ring gear - .025 to .045 inch (.65 to 1.14 mm). Loosen the thrust screw ½ turn, 180°.

1. Install the jam nut on the thrust screw, one half the distance between both ends (Figure 2-98).

2. Install the thrust screw into the carrier until the screw stops against the ring gear (Figure 2-98).

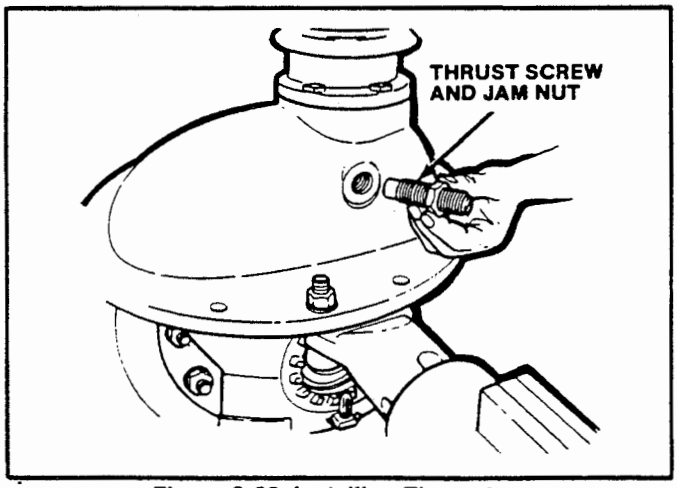


Figure 2-98. Installing Thrust Screw.

3. Loosen the thrust screw ½ turn, 180° (Figure 2-99).

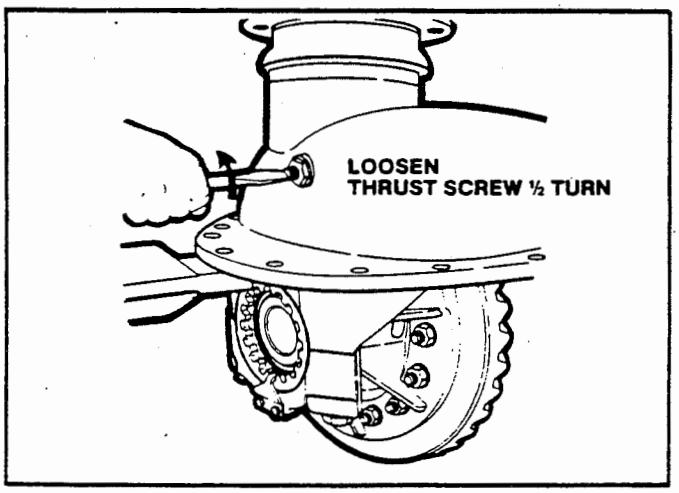


Figure 2-99. Adjusting Thrust Screw.

4. Tighten the jam nut to the correct torque value against the carrier (Figure 2-100). See the torque chart later in this section.

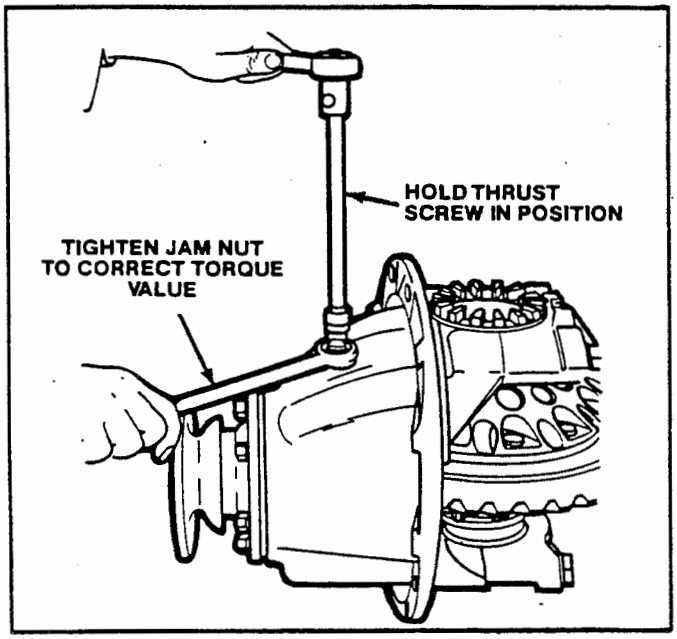


Figure 2-100. Torquing Jam Nut On Thrust Screw.

INSTALLING DIFFERENTIAL CARRIER INTO AXLE HOUSING

WARNING: Be careful when using cleaning solvents. Follow the solvent manufacturer's instructions for safe use to prevent injury.

1. Clean the inside of axle housing and the mounting surface where the carrier fastens. Use a cleaning solvent and rags to remove dirt. Blow dry the cleaned areas with air. Also see the procedure on cleaning axle assembly earlier in this section.

2. Inspect the axle housing for damage. Repair or replace the axle housing. See the procedure earlier in this section.

3. Check for loose studs in the mounting surface of the housing where the carrier fastens. Remove and clean the studs that are loose.

4. Apply liquid adhesive to the threaded holes and install the studs into axle housing. See the procedure outlined earlier. Tighten studs to current torque value. See the torque chart later in this section.

5. Apply silicone gasket material to the mounting surface of the housing where the carrier fastens. See the procedure earlier in this section.

6. Install the carrier into the axle housing. Use a hydraulic roller jack or a lifting tool.

CAUTION: Do not install the carriers using a hammer or mallet. A hammer or mallet will damage the mounting flange of carrier and cause oil leaks.

7. Install nuts and washers or capscrews and washers in the four corner locations around the carrier and axle housing. Tighten the fasteners hand tight at this time (Figure 2-101).

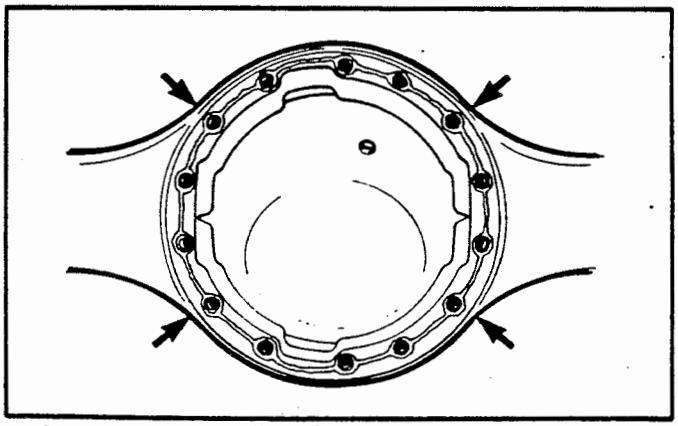


Figure 2-101. Installing Carrier Mounting Capscrews.

8. Carefully push the carrier into position. Tighten the four fasteners two or three turns each in a pattern opposite each other (see Figure 2-101).

9. Repeat step 8 until the four fasteners are tightened to the correct torque value. See the torque chart later in this section.

10. Install the other fasteners and washers that hold the carrier in the axle housing. Tighten fasteners to the correct torque value. See the torque chart later in this section.

11. Connect the driveline universal joint to the pinion input yoke or flange on the carrier.

12. Install the gaskets and axle shafts into the axle housing and carrier. The gasket and flange of the axle shafts must fit flat against the wheel hub (Figure 2-102).

13. Install the capscrews and washers that hold the axle shaft to the wheel hub. Tighten capscrews to the correct torque value. See the torque chart later in this section.

14. If the wheel hubs have studs, install the tapered dowels at each stud and into the flange of the axle shaft. Use a punch or drift and hammer if needed.

15. Install the nuts and washers on the studs. Tighten nuts to the correct torque value. See the torque chart later in this section.

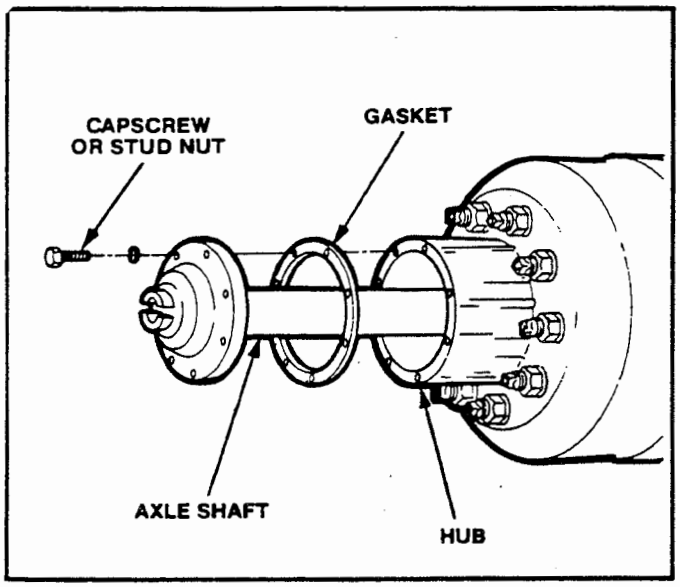


Figure 2-102. Installing Axle Shafts And Gaskets.

TORQUE VALUES FOR FASTENERS

GENERAL INFORMATION

1. The torque values in the following chart are for fasteners hat have a light application of oil on the threads.
2. If the fasteners are dry, increase the torque values by ten percent (10%).
3. If the fasteners have a heavy application of oil on the threads, decrease the torque values by ten percent (10%).
4. If you do not know the size of the fastener that is being installed, measure the fastener. Use the following procedure.

American Standard Fasteners

a. Measure the diameter of the threads in inches, dimension X (Figure 2-103).

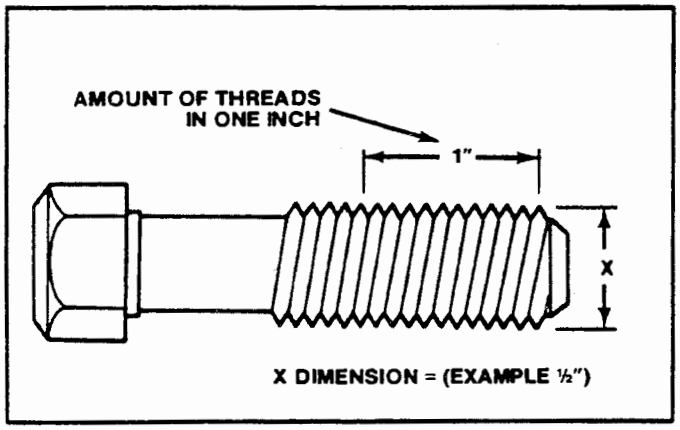


Figure 2-103. Determining Size Of American Standard Fastener.

b. Count the amount of threads there are in one inch (1.0 inch) (Figure 2-103). Example of an American Standard size fastener is .50 - 13. The .50 is the diameter of the fastener in inches (dimension X). The 13 is the number of threads in one inch (1.0 inch).

Metric Fasteners

a. Measure the diameter of the threads in millimeters (dimension X) (Figure 2-104).

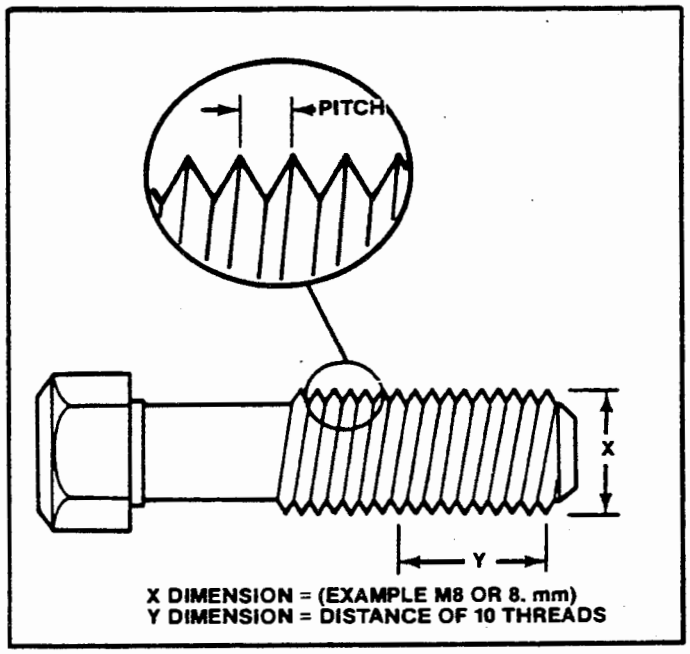


Figure 2-104. Determining Size Of Metric Fastener.

b. Measure the distance of ten (10) threads, point to point in millimeters (mm), dimension Y. Make a note of dimension Y (Figure 2-104).

c. Divide dimension Y by ten (10). The result will be the distance between two threads or pitch. Example of a Metric size fastener is M8 x 1.25. The M8 is the diameter of the fastener in millimeters (mm) (dimension X). The 1.25 is the distance between two threads or pitch.

5. Compare the size of fastener measured in step 4 to the list of fasteners in the following chart to find the correct torque value.

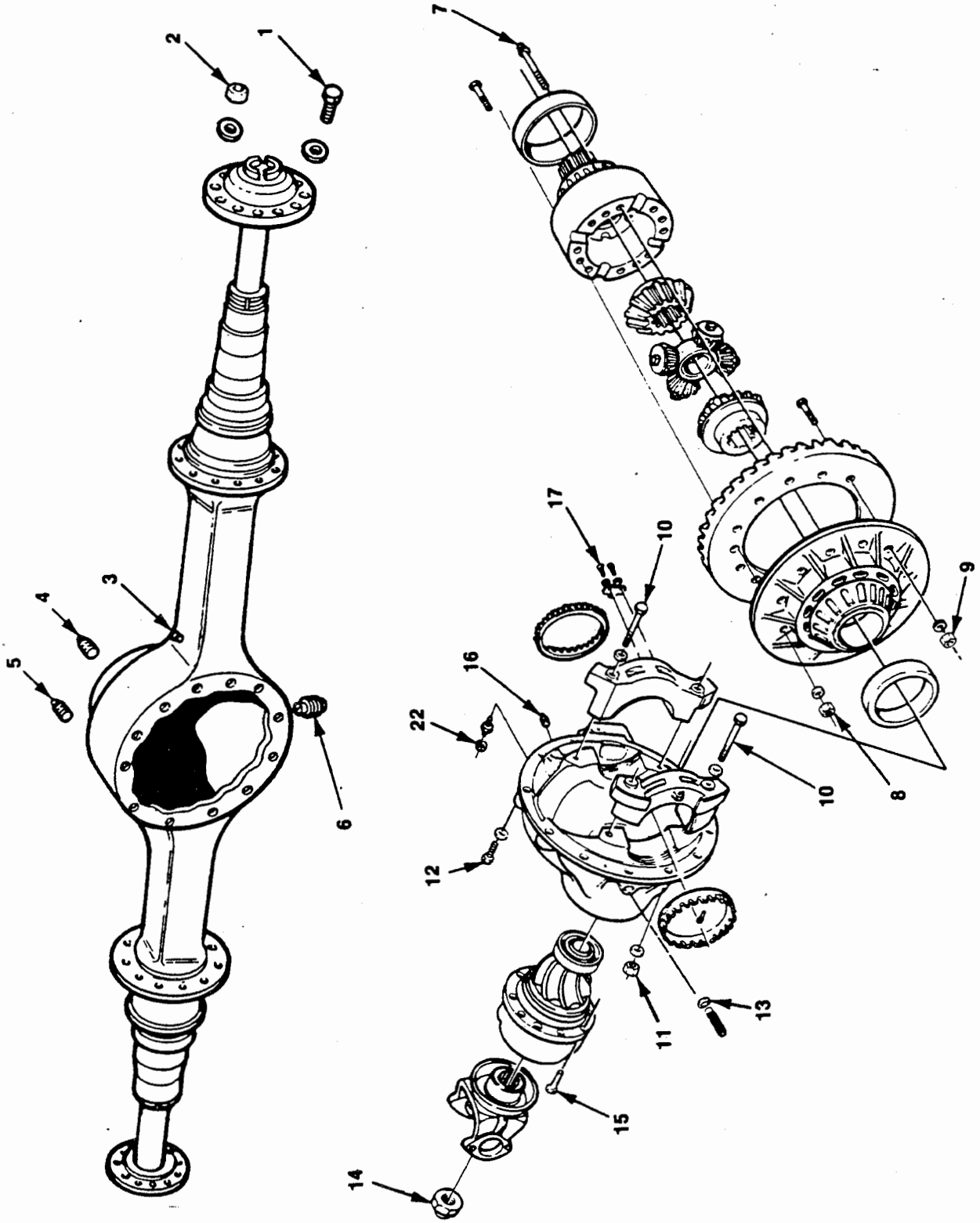


Figure 2-105. Axle Fastener Locations.

MC-9 MAINTENANCE MANUAL

FASTENER TORQUE CHART — Refer to Figure 2-105

	FASTENER		THREAD SIZE	TORQUE VALUE lb-ft (Nm)	
1.	Capscrew, Axle Shaft		.31-24	18-24	(24-33)
			.50-13	85-115	(115-156)
2.	Nut, Axle Shaft Stud		Plain Nut		
			.44-20	50-75	(68-102)
			.50-20	75-115	(102-156)
			.56-18	110-165	(149-224)
			.62-18	150-230	(203-312)
			Lock Nut		
			.44-20	40-65	(54-88)
			.50-20	65-100	(88-136)
			.56-18	100-145	(136-197)
			.62-18	130-190	(176-258)
3.	Breather		.38-18	20 minimum (27 minimum)	
4.	Plug, Oil Filter (Housing)		.75-14	35 minimum (47.5 minimum)	
5.	Plug, Heat Indicator		.50-14	25 minimum (34 minimum)	
6.	Plug, Oil Drain		.50-14	25 minimum (34 minimum)	
7.	Capscrew, Differential Case		.38-16	35-50	(48-68)
			.44-14	60-75	(81-102)
			.50-13	85-115	(115-156)
			.56-12	130-165	(176-224)
			.62-11	180-230	(244-312)
		Flange Head	M12 x 1.75	85-103	(115-140)
		Standard Hex Head	M12 x 1.75	75-95	(100-130)
			M16 x 2	203-251	(275-340)
8.	Nut, Differential Case Bolt		.50-13	75-100	(102-136)
			.50-20	85-115	(115-156)
			.62-11	150-190	(203-258)
			.62-18	180-230	(244-312)
			M12 x 1.75	74-96	(100-130)
9.	Nut, Ring Gear Bolt		.50-13	75-100	(102-136)
			.50-20	85-115	(115-156)
			.62-11	150-190	(203-258)
			.62-18	180-230	(244-312)
			M12 x 1.25	66-81	(90-110)
			M12 x 1.75	77-85	(104-115)
		Flange Head	M16 x 1.5	192-214	(260-290)
		Standard Hex Head	M16 x 1.5	190-225	(260-305)
10.	Capscrew, Bearing Cap		.56-12	110-145	(149-197)
			.62-11	150-190	(203-258)
			.75-10	270-350	(366-475)
			.88-14	360-470	(488-637)
			.88-9	425-550	(576-746)
			M16 x 2	181-221	(245-300)
			M20 x 2.5	347-431	(470-585)
			M22 x 2.5	479-597	(650-810)
11.	Nut, Housing to Carrier Stud		.44-20	50-75	(68-102)
			.50-20	75-115	(102-156)
			.56-18	110-165	(149-224)
			.62-18	150-230	(203-312)
12.	Capscrew, Carrier to Housing		.44-14	50-75	(68-102)
			.50-13	75-115	(102-156)
			.56-12	110-165	(149-224)
			.62-11	150-230	(203-312)
			.75-10	270-400	(366-542)
			M12 x 1.75	74-89	(100-120)
			M16 x 2	181-221	(245-300)
13.	Jam Nut, Thrust Screw		.75-16	150-190	(203-258)
			.88-14	150-300	(203-407)
			1.12-16	150-190	(203-258)
			M22 x 1.5	148-210	(200-285)
			M30 x 1.5	236-295	(320-400)

MC-9 MAINTENANCE MANUAL

	FASTENER	THREAD SIZE	TORQUE VALUE lb-ft (Nm)	
14.	Nut, Drive Pinion	.88-20	200-275	(271-373)
		1.0-20	300-400	(407-542)
		1.25-12	700-900	(949-1220)
		1.25-18	700-900	(949-1220)
		1.50-12	800-1100	(1085-1491)
		1.50-18	800-1100	(1085-1491)
		1.75-12	900-1200	(1220-1627)
		M32 x 1.5	738-918	(1000-1245)
		M39 x 1.5	922-1132	(1250-1535)
		M45 x 1.5	996-1232	(1350-1670)
15.	Capscrew, Bearing Cage	.38-16	30-50	(41-68)
		.44-14	50-75	(68-102)
		.50-13	75-115	(102-156)
		.56-12	110-165	(149-224)
		.62-11	150-230	(203-312)
		M12 x 1.75	74-96	(100-130)
16.	Plug, Oil Filter (Carrier)	.75-14	25 min	(34 min)
		1.5-11.5	120 min	(163 min)
		M24 x 1.5	35 min	(47 min)
17.	Capscrew, Lock Plate	.31-18	20-30	(27-41)
		M8 x 1.25	21-26	(28-35)

DRIVE AXLE LOAD TUBE REPLACEMENT

REMOVAL

After removing the drive axle differential assembly, the axle load tubes may be removed and new tubes installed.

An axle tube pulling and installing set, a pulling adaptor, a tube adaptor and a carrier pilot plate are required to perform this operation. Refer to the tool listing at the end of this section for the part numbers of these items. To remove the axle tube follow these steps (refer to Figure 2-106):

1. Place the pulling adaptor in position at the end of the axle tube inside the axle housing.
2. Place the tube adaptor in position at the hub end.
3. Insert the puller screw in the axle tube and secure the pulling adaptor with the hex nut.
4. Place the puller tube against the tube adaptor.
5. Place the hydraulic ram in position. Apply the speed nut against the ram head as shown.
6. Connect the ram to the hydraulic pump and apply pressure. The load tube will be withdrawn from the axle housing with continued applications of pressure.

INSTALLATION

To install the new load tube follow these steps (refer to Figure 2-107):

1. Insert the two puller screws in the axle housing and connect them with the connecting nut as shown.
2. Place the axle tube in position at the end of the axle housing.
3. Place the pulling adaptor in position at the outside end of the new tube. Also place one in the opposite end as a guide and secure the puller screw with the hex nut as shown.
4. Place the tube adaptor in position at the opposite end of the axle housing.
5. Place the puller tube in position against the tube adaptor as shown.
6. Install the carrier pilot plate assembly.
7. Position the hydraulic ram and screw the speed nut tightly against the ram head.
8. Connect the ram to the hydraulic pump and apply pressure until the load tube flange is flush with the end of the axle housing.

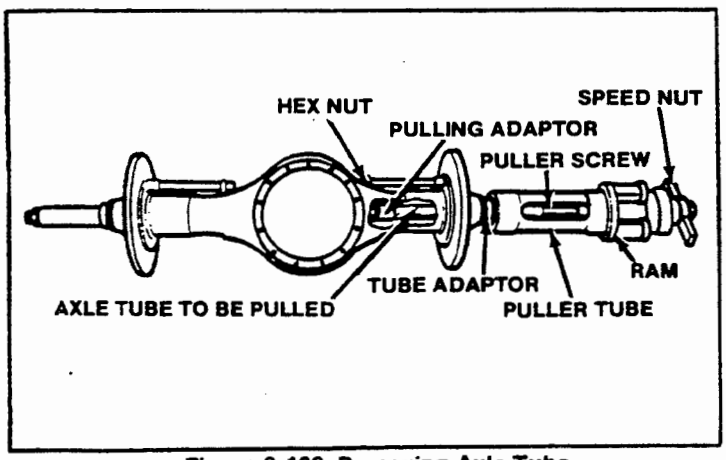


Figure 2-106. Removing Axle Tube.

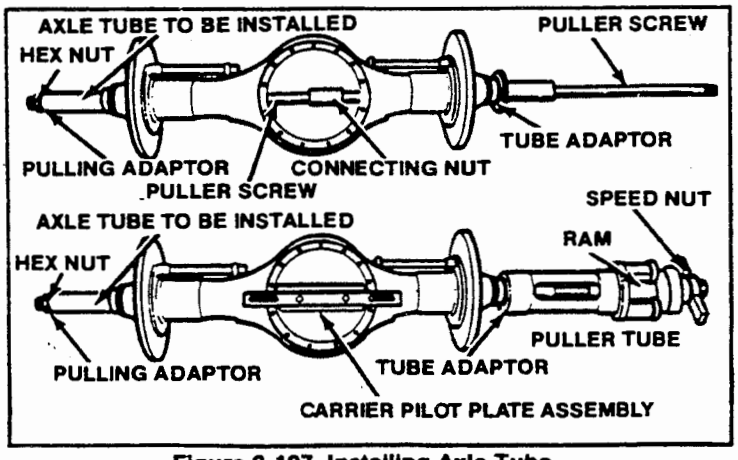


Figure 2-107. Installing Axle Tube.

MC-9 MAINTENANCE MANUAL

RAILING AXLE

Two independent rear trailing axles are mounted behind the rear drive axle. Each axle carries a single wheel and tire, with outside face 3-9/16" (90.4 mm) in from the outside face of the outside dual tire of the drive axle. Each axle pivots independently on a trunnion, allowing sufficient independent movement. Refer to Section 10 for lubrication.

Both of the swingarm type stub axles have hubs, bearings, seals and attaching parts which are identical to those on the front axle. See figure 2-108.

REMOVAL

Rear trailing wheels are carried on independent oscillating axle units, one for each wheel, attached to an axle tube located behind the rear driving axle.

To remove the right or left trailing axle assembly:

1. Exhaust air from suspension bellows by turning the air release valve to the OFF position (lever in horizontal position) until air is released from air springs.
2. Disconnect hose from the brake chamber.
3. Remove the wheel.
4. Remove the clamp which retains the axle assembly to the axle tube.
5. Remove screws holding the air springs to the bellows support plate.
6. Slide trailing axle assembly off cross tube bearing.

CAUTION: Do not apply air brakes until reassembled, as loss of air from brake system will result.

INSTALLATION

1. Install cross tube to bogie leg mounting plates, using ¾"-16 UNF capscrews. Torque to 315 ft. lbs. (427 Nm). Tighten outer bolts fully first and inner next.
2. Install cross tube brass bushing. With vent plugs removed, install new trailing arm assembly. Install retaining clamps at arm and cross tube assembly.
3. Reinstall bellows to spring seat. Reinstall the balance of assemblies and parts in the reverse order of removal.

Refer to Section 10 of this manual for lubrication of brake camshafts and cross tube. When installing wheel oil seals, refer to Section 15 of this manual. Add SAE 30 oil to wheel hubs if required.

ALIGNMENT

Trailing wheel alignment must be checked when replacing axles. Toe in of 0" to a maximum of ⅛" (3.17 mm) is acceptable. Rear wheel track is 76.5" (1.943 m). On some coaches with toe-out conditions, minor corrections beyond the above limit can be made by installing 20 Ga shims between flanges at inner mounting bolts.

NOTE: The inner and outer flange faces of cross-tube mounting must contact the bogie leg flanges after the bolts are tightened.

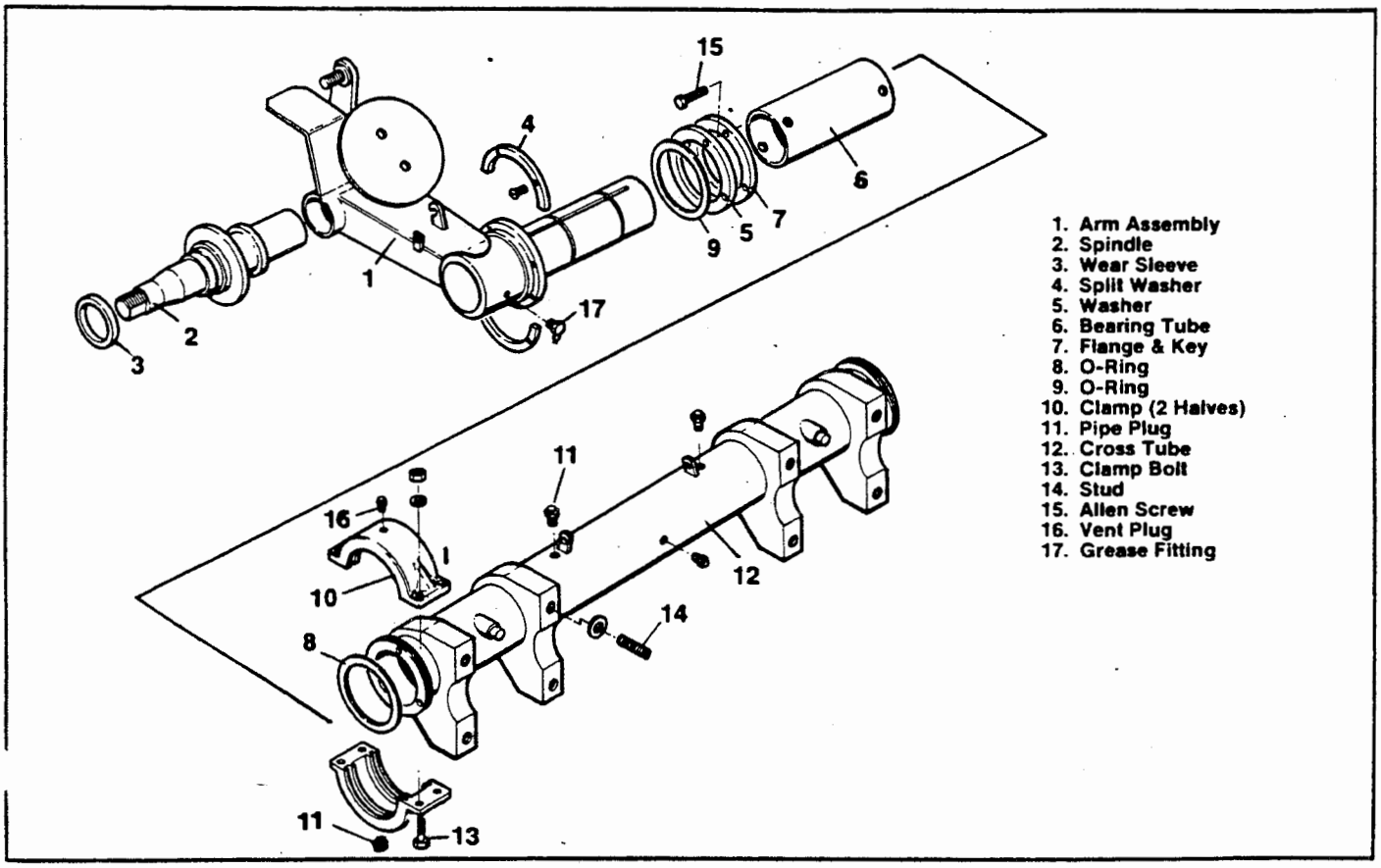


Figure 2-108. Trailing Axle Assembly.

MC-9 MAINTENANCE MANUAL

SPECIFICATIONS

DRIVE AXLE

DRIVE AXLE

Manufacturer	Rockwell Standard
Wheel Track (from center of duals)	70.6" (1,793 mm)
Gears, Type	Hypoid
Axle, Type	Full Floating, Pressed Steel Housing
Rear Axle Ratio (Std)	3.73:1
Rear Axle Lube Capacity	20 Qts. (18.9 liters)

CLEARANCE

Differential Bearing End Play	0.000" (.000 mm)
Differential Gear Run-Out Max.	0.008" (.203 mm)
Hypoid Gear Backlash (New)	0.010" (.254 mm)
Hypoid Gear Backlash Limits	0.005"-0.015" (.127 mm-.381 mm)

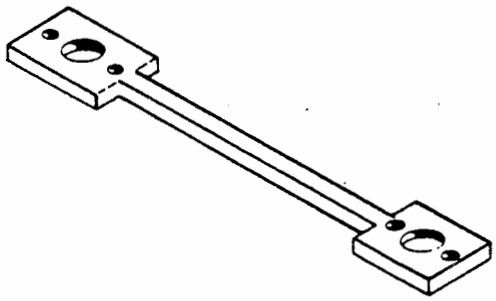
TRAILING AXLE

Wheel Track	81.5" (2,070 mm)
Trailing Wheel Toe In	¼" ± ¼" (6.3 ± 6.3 mm)

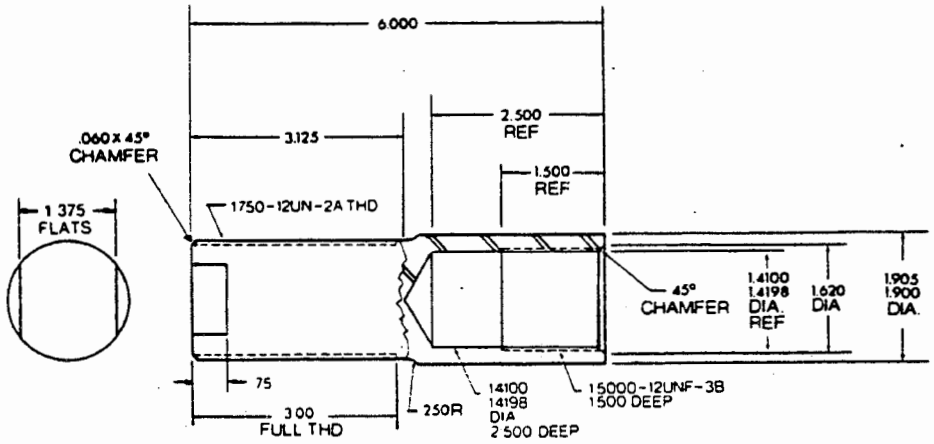
MC-9 MAINTENANCE MANUAL

SERVICE TOOLS

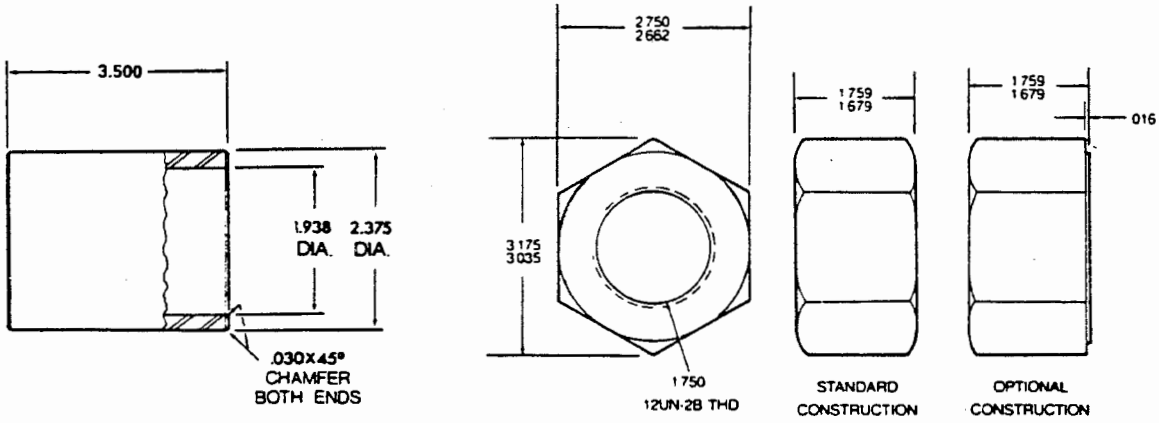
SOME OF THE TOOLS USED FOR THE MAINTENANCE PROCEDURES OUTLINED IN THIS SECTION ARE NONSTANDARD. THEY ARE, HOWEVER, AVAILABLE FOR PURCHASE FROM MOTOR COACH INDUSTRIES, TRANSPORTATION MANUFACTURING CORPORATION AND UNIVERSAL COACH PARTS. WHERE PRACTICAL, THEY MAY BE FABRICATED BY THE SERVICE FACILITY.



20-41 Trans. & Differential Flange, Holding Fixture For Torquing Nut



SHAFT

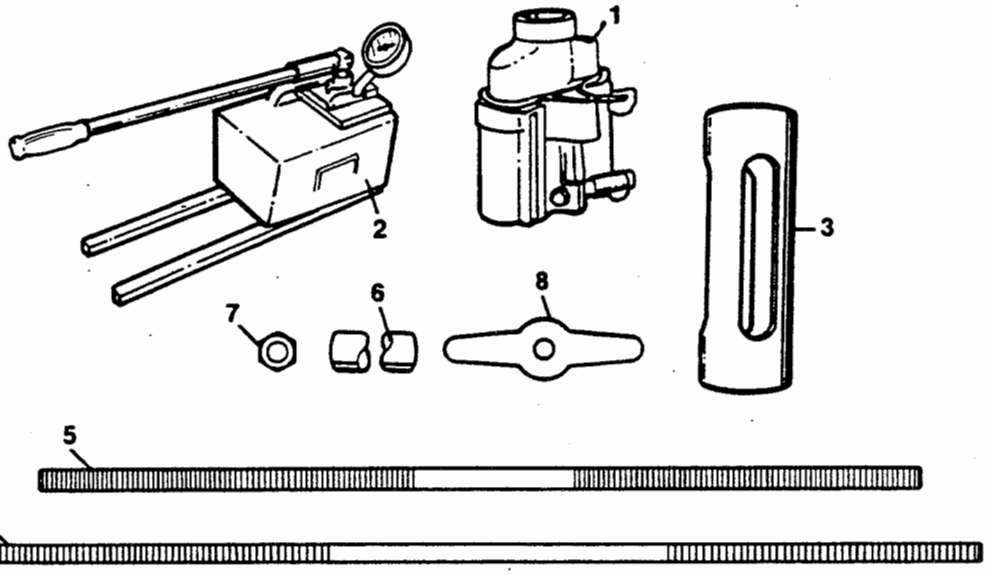


COLLAR **NUT**

20-142 Tool Kit — Yoke or Companion Flange Installation
20-143 Shaft 20-144 Collar 20-145 Nut

MC-9 MAINTENANCE MANUAL

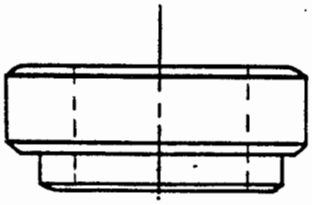
DRIVE AXLE TUBE PULLING TOOLS



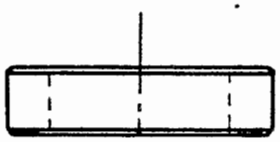
CONTENTS OF 20-313 SET

1 — 100 TON HYDRAULIC RAM
2 — TWO SPEED HYDRAULIC PUMP
3 — PULLER TUBE
4 — PULLER SCREW 71"
5 — PULLER SCREW 59"
6 — CONNECTING NUT
7 — HEX NUT
8 — ADJUSTING SPEED NUT

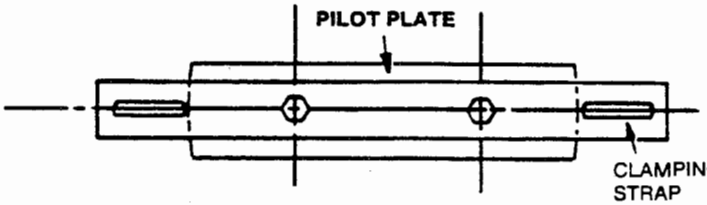
20-313 Axle Tube Pulling/Installing Set



* 20-314 PULLING ADAPTOR



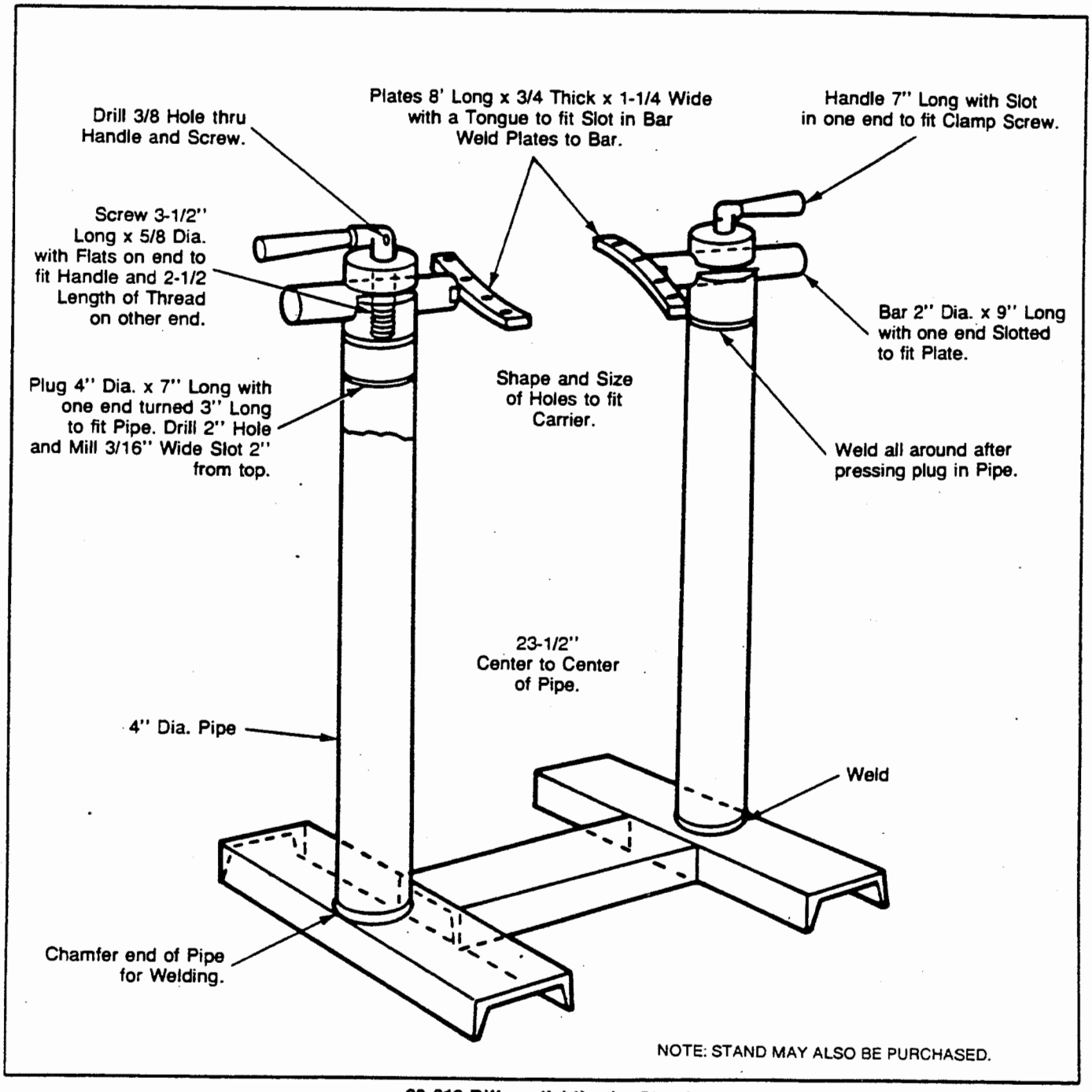
* 20-315 TUBE ADAPTOR



* 20-316 CARRIER PILOT PLATE
* 20-317 CLAMPING STRAP

* NOT INCLUDED IN 20-313 SET, BUT REQUIRED ALONG WITH SET - ORDER SEPARATELY.

MC-9 MAINTENANCE MANUAL


Drill 3/8 Hole thru Handle and Screw.
Plates 8' Long x 3/4 Thick x 1-1/4 Wide with a Tongue to fit Slot in Bar Weld Plates to Bar.
Handle 7" Long with Slot in one end to fit Clamp Screw.
Screw 3-1/2" Long x 5/8 Dia. with Flats on end to fit Handle and 2-1/2 Length of Thread on other end.
Bar 2" Dia. x 9" Long with one end Slotted to fit Plate.
Plug 4" Dia. x 7" Long with one end turned 3" Long to fit Pipe. Drill 2" Hole and Mill 3/16" Wide Slot 2" from top.
Shape and Size of Holes to fit Carrier.
Weld all around after pressing plug in Pipe.
23-1/2" Center to Center of Pipe.
4" Dia. Pipe
Weld
Chamfer end of Pipe for Welding.
NOTE: STAND MAY ALSO BE PURCHASED.

20-318 Differential Carrier Stand.

Date 1-1-89

MC-9 MAINTENANCE MANUAL

SECTION 3
BODY

SUBJECT	PAGE
Air Operated Baggage Doors	3-22
Baggage Doors	3-21
Bi-Parting Entrance Door	3-27
Body Repairs	3-9
Carpeting	3-12
Coach Body	3-1
Coach Dimensions	3-3
Coach Jacking Points	3-8
Compartment Doors	3-4
Destination Sign	3-40
Driver's Seat	3-40
Emergency Escape Hatches	3-24
Entrance Door	3-24
Exterior Maintenance	3-4
Exterior Rear View Mirrors	3-41
Fiberglass Repairs	3-16
Heated External Rearview Mirrors	3-42
Imron Paint	3-14
Indirect Lights	3-43
In-Station Lights	3-43
Interior	3-4
Lifting and Towing	3-7
Maxi-Galley	3-44
Mini-Galley	3-48
Modesty Panels	3-13
Replacement of Floor Covering	3-14
Retractable Entrance Step	3-43
Rivet Chart	3-10
Service Tools	3-52
Upholstery	3-11
Vinyl Repair	3-13
Windows	3-18
Windshields	3-19
Windshield Washers	3-39
Windshield Washer Troubleshooting	3-39
Windshield Wipers	3-35
Windshield Wiper Troubleshooting	3-37
Service Bulletin Page	

Date 1-1-89

MC-9 MAINTENANCE MANUAL

SECTION 3

BODY

SUBJECT	PAGE
Air Operated Baggage Doors	3-22
Baggage Doors	3-21
Body Repairs	3-9
Carpeting	3-12
Coach Body	3-1
Coach Dimensions	3-3
Coach Jacking Points	3-8
Compartment Doors	3-4
Destination Sign	3-32
Modesty Panels	3-13
Driver's Seat	3-32
Emergency Escape Hatches	3-24
Entrance Door (Manual Controls)	3-24
Exterior Maintenance	3-4
Exterior Rear View Mirrors	3-33
Fiberglass Repairs	3-16
Heated External Rearview Mirrors	3-34
Imron Paint	3-14
Indirect Lights	3-35
Interior	3-4
Lifting and Towing	3-7
Replacement of Floor Covering	3-14
Retractable Entrance Step	3-35
Rivet Chart	3-10
Service Tools	3-36
Upholstery	3-11
Vinyl Repair	3-13
Windows	3-18
Windshields	3-19
Windshield Washers	3-31
Windshield Washer Troubleshooting	3-31
Windshield Wipers	3-27
Windshield Wiper Troubleshooting	3-29
Service Bulletin Page	

MC-9 MAINTENANCE MANUAL

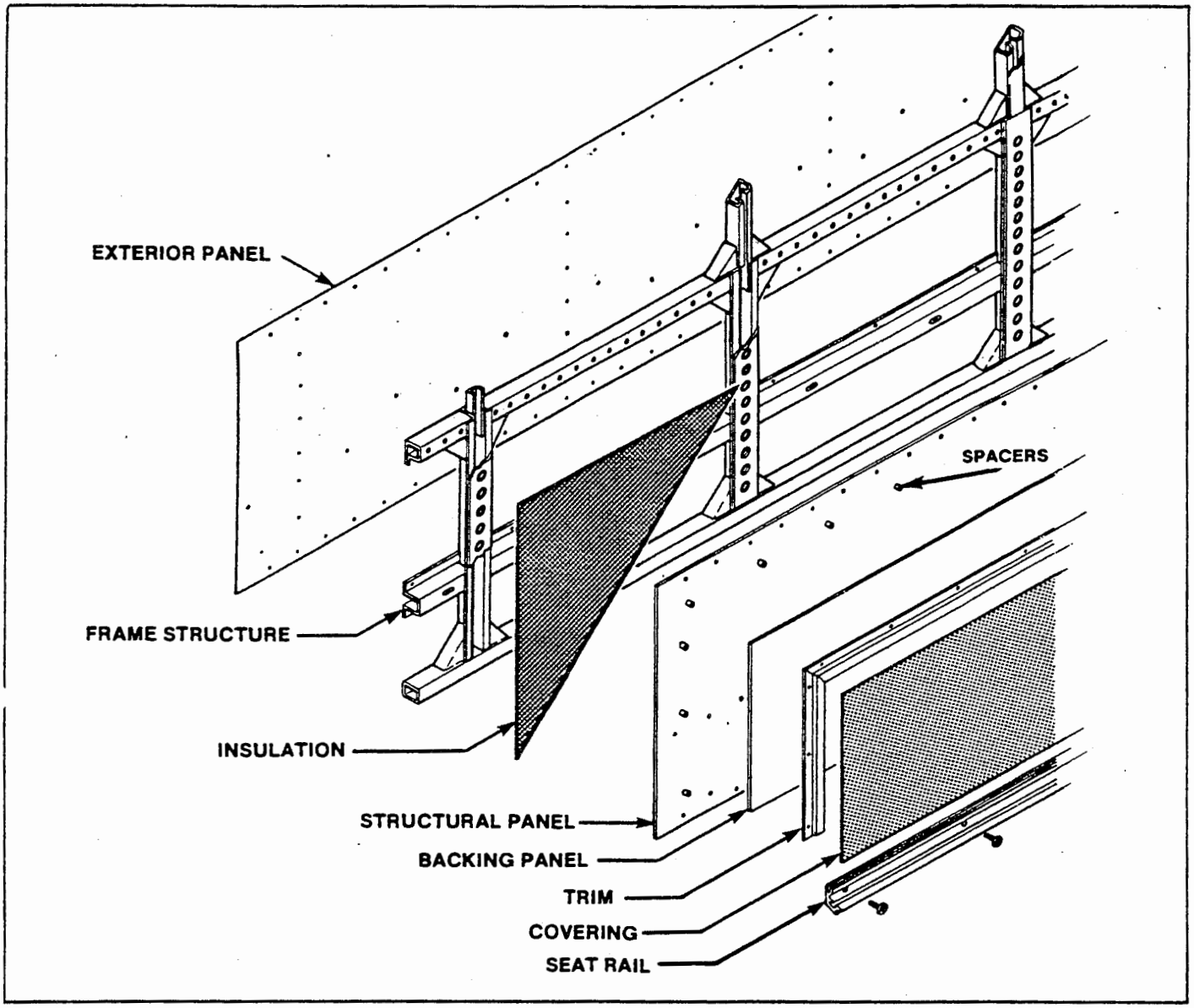


Figure 3-1. Sidewall Construction.

COACH BODY

BODY PANELS

The MC-9 coach uses a welded, single-piece monocoque frame. Below the belt rail 16 and 18 gauge stainless steel is used while the upper body is framed in high tensile, low alloy steel, primed before installation. Front body panels are 24 gauge (.6 mm) stainless steel with a 20 gauge (1 mm) stainless steel trim panel provided between the headlights. Removable stainless steel iron moldings are used under the windshields providing access to the windshield wipers and door control. All side panels below the floor line are 24 gauge (.6 mm) stainless steel fluted on 4" (102 mm) centers. See figure 3-1.

The exterior center roof and sidewall panels immediately below the passenger windows are high tensile .064" (1.6 mm) prestressed primed and painted aluminum. The interior has aluminum alloy panels riveted to the frame with one panel used to provide a continuous airway for the heated or cooled air from the main ducts. The rear panel above the floor line is 24 gauge (.6 mm) smooth stainless steel and the lower panels on the service doors are beaded 24 gauge (.6 mm) stainless steel. Condensation drain tubes are provided within the frame.

The front roof cap and the rear crown panel are ⅛" (3.17 mm) thick molded fiberglass and incorporate molded indentations for lamps. Main roof panels are .051" (1.29 mm) high tensile aluminum prestretched on installation and riveted in place.

All exterior panels are riveted securely to the frame members. Dissimilar metals are separated by mastic tape or mylar tape. Roof and sidewall panels are insulated with 2" (51 mm) medium density, fiberglass, compressed during application of interior panels, with joints sealed with aluminum pigmented mastic. Sidewall insulation is contained in waterproof envelopes. High density fiberglass with an asbestos blanket is used for insulation and sound-deadening at the rear bulkhead. A double floor construction over the axles is filled with insulating material to reduce the transfer of heat and noise to the inside of the coach.

MC-9 MAINTENANCE MANUAL

MOLDINGS

Extruded aluminum drip moldings extend along the sides of the coach above the window line. Exterior trim moldings are attached to the body to cover the horizontal rivet lines at both sash and belt lines while black painted aluminum moldings cover the window posts. Stainless steel screws and nylon washers are used to eliminate the contact of dissimilar metals to prevent corrosion of the moldings.

BAGGAGE COMPARTMENTS

Three full-width, underfloor compartments are provided between front and rear drive axles. Total capacity is 300 cubic feet (8.5 cubic meters), with a clear 33" x 54½" (840 mm x 1380 mm) opening provided to each compartment on both sides of the coach. All compartment doors are full sealed, Pantograph, vertical lift type, and each has a flush mounted breakaway-type latch handle with provision for padlock and customs seals. All doors are interchangeable.

BUMPERS

The standard rear bumper is made of 12" (305 mm) wide, extruded, hard alloy anodized aluminum, back-ribbed for maximum strength. An optional energy absorbing rear bumper may be installed in place of the standard rear bumper. The front bumper is hinged at the top for easy access to the spare tire compartment. The rear bumper is easily removed for access to the engine compartment. Extruded anodized aluminum corner bumperettes are mounted on rubber cushion pads at all four corners of coach and extruded aluminum rub rails extend along each side of the coach to offer maximum protection to lower body panels from baggage carts and vehicles. Molded rubber fenders are installed at front wheelhousings and the rear wheelhousings are trimmed with anodized aluminum bars. Three-piece fenders can be installed at the rear housings as optional equipment. Front and rear wheel splash aprons are optional. For coach dimensions, see figure 3-2.

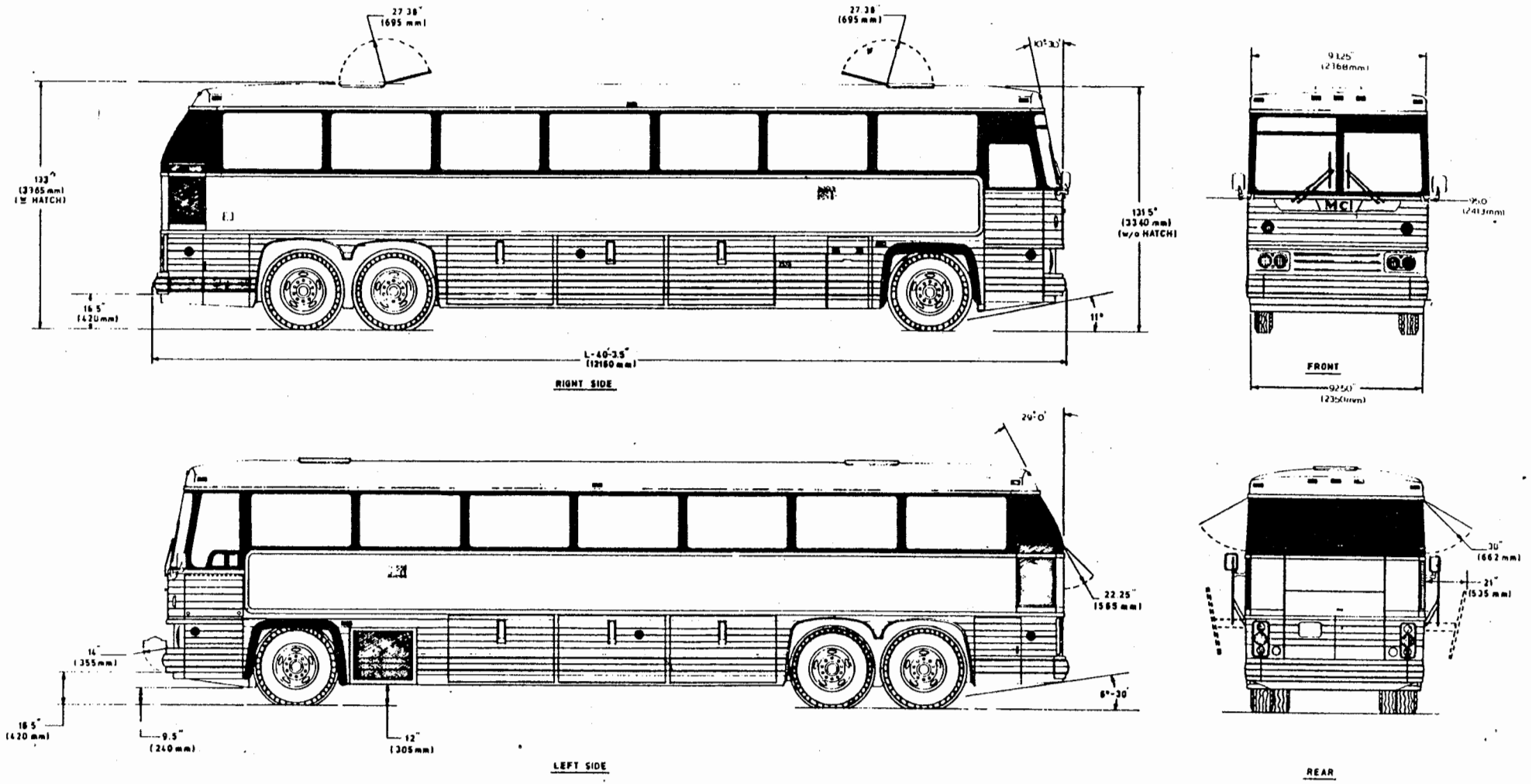


Figure 3-2. MC-9 Dimensional Chart.

MC-9 MAINTENANCE MANUAL

INTERIOR

The driver's floor, front entrance area and front aisle are all at the same level. The floor is ½" (13 mm) thick 5-ply waterproof fir plywood. The floor is securely attached to the underframe with elevator bolts and self-tapping, countersunk screws and all joints are sealed with mastic. The underside of the floor is treated with fire retardant paint and the top is sanded and covered with a heavy duty, quality rubber. The following are used: 5/16" (8 mm) ribbed, metal backed stepwell tread plates; 3/16" (5 mm) ribbed entrance area and ramped aisle area (no metal back); ⅛" (3 mm) smooth driver's area; ⅛" (3 mm) smooth center aisle; ⅛" (3 mm) smooth under seats.

The seats are securely fastened with high tensile tee-bolts in a high strength aluminum alloy track on the wall and a stainless steel track in the floor which are securely welded to the coach frame. Tracks are flush to top of floor covering.

Vinyl clad aluminum alloy luggage racks are mounted in extruded clear anodized aluminum alloy channels. The aisle side extrusion incorporates tracked passenger reading lights and a continuous length ribbon switch for the passenger chime system. The wall side extrusion incorporates an indirect interior lighting system. Transverse strips on the interior surface of the parcel rack prevents shifting of parcels. Front of parcel racks have end caps in color matched, self-skinned urethane foam. The parcel rack hangers are formed stainless steel.

The ceiling at the extreme front and the rear window area is color impregnated, fiberglass reinforced plastic, molded panels while the main ceiling area is vinyl clad aluminum. Vinyl and aluminum moldings cover panel joints. Lower side wall trim below windows is melamine paneling.

COMPARTMENT DOORS

SURGE TANK FILLER DOOR

The surge tank filler door is located on the right hand side of the coach at the rear above the radiator compartment. The door is front hinged, piano type and is spring loaded in the closed position.

FRONT SERVICE DOOR

A left front service door below the driver's floor is front hinged, held closed by two quarter-turn Dzus fasteners. Access is provided to the accessory and air ride tank, charging valve, steering components, windshield washer and horns.

CONDENSER COMPARTMENT DOOR

The condenser compartment door is front hinged, piano type and is held closed by quarter-turn Dzus fasteners. A rod type prop automatically holds the condenser door when fully opened. Access is provided to condenser fan and motor, receiver tank and other air conditioning components.

BATTERY COMPARTMENT DOOR

The battery compartment door is top hinged and held closed by an over-center spring loaded latch. A prop rod holds the door open while providing access to batteries, air conditioning filter and battery disconnect switch.

ELECTRICAL JUNCTION PANEL SERVICE DOOR

The electrical junction panel service door is located below the driver's window. It is top hinged and held closed by two quarter-turn Dzus fasteners. A prop rod holds the door open.

ENGINE SERVICE DOORS - REAR

The rear engine compartment service doors are side hinged. A flush-mounted paddle handle latch is installed on right door which overlaps the edge of the left door. Prop rods are provided on both doors to hold the open position.

BLOWER COMPARTMENT DOOR

The blower compartment door is top hinged and held closed by two spring loaded latches. A prop rod automatically holds door when fully opened. Access is provided to blower gear box, sight glass, blower fans and scrolls, and blower pulley.

FUEL TANK FILLER DOOR

The fuel tank filler door is front hinged with dual over-center springs to securely hold door both opened and closed. Provision is made in the body paneling for access to the fuel tank assembly and drain plug if removal is necessary. This panel is retained at the top by two bolts and at the bottom by a pin.

RIGHT REAR SIDE SERVICE DOOR

The right rear side service door is front hinged with upper and lower brackets. To open turn handle counterclockwise. Access is provided to the chemical tank and waste water tank drain valves, air conditioning compressor, switches, solenoids, trailing axle air dump valve and left bank of engine.

LEFT REAR SIDE SERVICE DOOR

The left rear side service door is front hinged with upper and lower brackets. To open turn handle counterclockwise. Access is provided to the rear junction box components, alternator, air cleaners and right bank of engine.

EXTERIOR MAINTENANCE

Regular washing to remove accumulated dust and dirt is recommended. This is all that is required on the exterior stainless steel panels below the windows. The panel caps between the windows are anodized aluminum. Avoid the use of alkaline cleaners on aluminum parts as they will attack and corrode aluminum just as iron and steel will rust. Use only a mild detergent and a soft brush. Abrasive cleaners, polish or steel wool should not be used as they will remove the protective coating and may scratch and discolor the finish.

CORROSION PREVENTION

Preventive maintenance is a key factor in avoiding corrosion and must be considered as part of the regular service intervals.

The entire underside of the coach is sprayed with a heavy application of asphalt base undercoating. Also, all fasteners are corrosion resistant.

The type of operating environment a coach is exposed to determines the amount of dirt and corrosion that it will accumulate over any given operating period. Corrosion is one of the most costly factors of part failure and abbreviated part life. It is, however, an item that can be controlled when it is conscientiously looked for and the proper steps taken within a reasonable amount of time.

Certain areas of the coach are more vulnerable to corrosion than others and it is these areas that should be addressed. For example, the rear baggage compartment bulkhead in the rear wheelhousing area should be examined regularly for corrosion. This location contains many key components: relay valve, suspension air filter, dry air tank, inversion valve, parking brake, pressure regulator, and numerous other valves and fittings. Other areas include the front wheelhousing area, spare tire compartment, front left side service area, and engine compartment.

Road splash will affect undercarriage, sides of coach, fresh air intakes, condenser coil and engine compartment. These areas must be thoroughly cleaned to remove "dirt packs" from flanges, channel and ledges. These places accumulate dirt and salt and hold it in direct contact with steel and aluminum surfaces. Use an understructure high pressure spray as part of a regular wash. Damaged undercoating or paint should be promptly repaired before corrosion can start.

Frequency of wash periods depends on operating conditions. During periods of exposure to salt daily washing as described above is necessary.

If underbody parts show evidence of rust or corrosion, treat as follows:

1. Clean. Remove dirt, grease and oil, by solvent washing.
2. Remove corrosion as well as all loose deadener coating by sanding with wire brush or with other means.

> **CAUTION: Sandblasting can be used for cleaning bulkheads, brackets and other structural members. However, it should not be used for exterior side paneling. Extreme care should be taken not to sandblast excessively.**

After removing all corrosion, correct priming, painting and undercoating must be applied to prevent further damage.

ROUTINE CLEANING

Wash and rinse water should be free of solids. It is especially important to assure that recirculating systems are properly designed, maintained and monitored for efficiency. In all cases suppliers of recirculating systems should provide assurance that their equipment and techniques will function satisfatorily with Lucite® windows.

Two types of detergent are necessary for optimum washing efficiency. A solvent-based dissolving type of detergent should be used with the prewash spray. A highly lubricating type of detergent should be used with brushes.

In each case, the detergent manufacturer should be consulted regarding recommendations on concentration. Additionally, the water/detergent mixture should be 90°F to 110°F to improve cleaning efficiency.

Most high quality detergents contain sequestering agents and are effective in water of up to eight grains hardness. This does, of course, depend heavily on the particular detergent and its concentration. If the detergent does not contain sequestering agents, water should be softened to four grains hardness or less for effective detergent action. In all cases, the detergent supplier should be contacted for recommendations on detergent and soft water requirements.

A good, high pressure water spray prewash is vital to remove as much grit and grime as possible before brushing. Detergent may or may not be employed with the prewash. If detergent is used, follow the recommendations above, allowing enough time for the detergent to soften the grime before other washing steps. If detergent is not used in this step, please follow the directions under "Detergent Prewash" below. For alternative washer arrangements, please see figure 3-3.

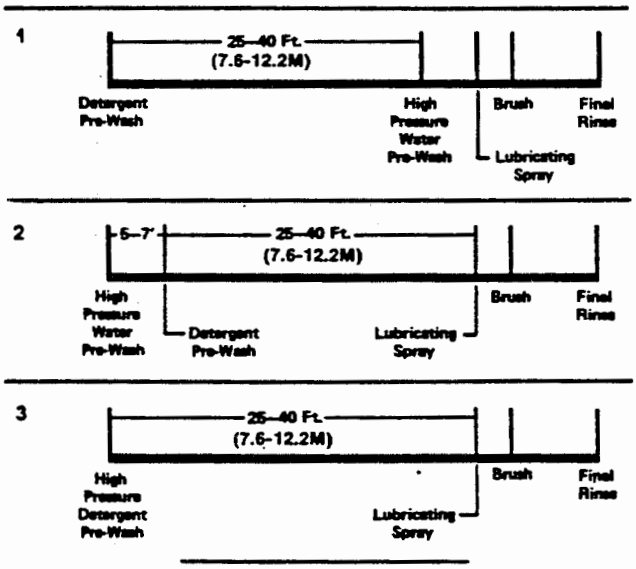


Figure 3-3. Washing Equipment Schematic.

DETERGENT PREWASH

In cases where the initial prewash spray does not contain detergent, we recommend that a small additional spray arm be installed to cover the window area only. This arm should be located far enough from the prewash spray so that its effect is not diluted by additional water (probably 5-7 feet [1.5-2.1 m]). Alternatively, this could be located in front of the main prewash station if sufficient distance can be provided so as to allow the detergent time to act (25 to 40 feet at 1-2 MPH [7.6-12.2 m at 1.6-3.2 km/h]). Where possible, warm water (90°-110°F [32°-43°C]) should be used with detergent.

MC-9 MAINTENANCE MANUAL

FILAMENT

Like the washer, a wide variety of filaments can be employed for washing. Although expensive and hard to get, Tampico fiber is one of the best. Filament having a high wax content (i.e., certain polyethylenes) should be avoided since the wax deposits on windows and painted surfaces. Polypropylene is normally satisfactory and may be flagged for optimum performance.

Synthetic filament is normally supplied as an "X" cross-sectional shape. Since this type of cross-section can trap grit against the side, it is recommended that filament of a round or circular cross-sectional shape be used. Filament suppliers make round filament available upon request.

Brush pressure (see below) and amount of filament in contact with the coach are the two factors most damaging to windows of Lucite SAR and to painted coach surfaces. It is most important that no more than six inches of filament overlap the bus side as the brush turns. The less filament in contact with Lucite SAR, the better the guard against scratches during cleaning. It may be necessary to provide a soft roller or wheel guide on the brush arm to prevent over-engagement of bus and brush.

BRUSH PRESSURE

Normally, the amount of filament in contact with the window and brush pressure are directly proportional to one another. As brush pressure is lowered, the amount of filament in contact with the window is less. Total pressure should be as low as possible. Again, the wheel concept outlined above can be used to prevent excessive brush contact.

Many washers, particularly those with "wrap-around" features, are deisgned with more than one set of side brushes. Since abrasion occurs when brushes contact the coach, it is important to minimize exposure of the windows to brushing. Therefore, it is recommended that one set of brushes be deactivated from the side washing function.

Where two sets of side brushes are deemed necessary, it is especially important that they be properly adjusted and maintained to minimize abrasion potential.

LUBRICATING SPRAY AT BRUSH/WINDOW INTERFACE

Spray in this area must effectively lubricate the brush/coach interface. Since this is the point of greatest mechanical agitation (and, therefore, greatest potential for scratching), lubrication at this point is essential. We recommend installation of a spray line to provide lubrication directly at the brush/coach interface rather than wet the bus or brush independently. A high lubrication detergent should be used along with warm water. If desired, this spray line can be used for the window area only.

RINSE SPRAY

Many washers already include a rinse spray to clean grit from the brush. This should be retained and its position optimized to do the most effective job. The final rinse should be a high pressure, high volume (with emphasis on the high volume) rinse with a minimum delivery of 125 GPM (473 l/minute).

VEHICLE SPEED

Speed of the coach through the prewash, wash and rinse should be one to two MPH (1.6-3.2 KPH). The bus should never be stopped while in contact with the brushes.

CLEANING LUCITE® WINDOWS

Conventional techniques may be used to clean Lucite® S-A-R. However, care should be taken to use a clean, soft (unsized) cloth. The surface of the window should be wetted with the cleaning solution before wiping. When oily surface contamination is present, the cleaning solution may not wet the surface thoroughly until it is rubbed with the cloth.

Household cleaners which have been tested and found effective in cleaning Lucite® S-A-R include Easy-Off, Windex, Glass Plus, Top Job, Mr. Clean and Fantastik. Industrial cleaners effective on the acrylic windows are Neleco Subway Soil Solvent (Neleco Products, Inc.) and C-1102 Alkaline Cleaner (DuBois Chemicals).

To remove paint, ink marks and graffiti which are resistant to household cleaners, use a soft cloth saturated with isopropanol or an aliphatic hydrocarbon solvent. Do not use abrasive cleaners. Avoid using razor blades or other sharp instruments which might gouge the surface.

Two commercially available anti-static cleaners which effectively clean Lucite® S-A-R windows and reduce the tendency for static charge build-up are "Like-Magic" Type NI-5, Merchandise Presentations, Inc., 3960 Merritt Avenue, New York, NY 10466 and "Trend" Antistat Cleaner, Dawn Products, P.O. Box 24, Englewood, Colorado 80110. Follow the manufacturers' instructions when using the antistatic cleaners.

REPAIR

The following information concerns acrylic windows which have been damaged byen lightly coated with conventional automobile paste wax and polished with an electrically operated buffing pad. Do not use a cleaner/polish (wax) since the fine abrasives in such compounds will scratch the surface of the window.

When buffing, speed and pressure are critical factors. The acrylic must not be overheated; the buffing wheel should be kept in constant motion across the window surface to prevent overheating.

Deeper or wider scratches may be made less offensive by applying acrylic lacquer directly on the scratch. Such a coating may be based on EVALCITE® 2041 acrylic resin. Solvents should be toluene and xylene in a 75/25 blend, although this ratio may be changed to adjust drying time.

WARNING: Toluene and xylene are hazardous materials. Read and follow all precautions on containers. Use of a proper respirator is recommended to avoid breathing vapors. Adequate ventilation should be provided. Protect eyes and skin from contact with these solvents.

The prepared lacquer may be applied with an artist's paint brush (natural bristle only) or from a glass (not plastic) syringe. For assistance in preparing such a lacquer, you may want to contact a local paint company.

For deep scratches and gouges, the window surface must be removed and the substrate repaired for the most effective repair. Such procedures have not been developed by the manufacturer.

For all lacquer-repaired acrylic windows, the repaired area will exhibit less abrasion resistance than the surrounding surface area.

Lucite® and Evalcite® are trademarks of the DuPont Company.

LIFTING AND TOWING

TMC/MCI has available an I-beam frame assembly which can be used for lifting and towing. The dolly (part No. 20-300) is recommended whenever a coach is to be towed with the front wheels off the ground. It is shown in Figure 3-4.

CAUTION: The following procedure explains the use of the dolly developed for use by authorized and experienced tow truck operators to lift and tow only the affected coach models. This tool and procedure are NOT approved for any other coach models or applications. Prior coach models have not been approved for lifting and towing.

Also, this procedure explains only the recommended method to attach the tool to the coach. It does not attempt to explain or instruct personnel in all conceivable proper methods and details for safe lifting and towing of buses. TMC and MCI recommend that this tool and procedure be used only by tow truck operators authorized and experienced in towing intercity coaches.

TMC/MCI cannot be responsible for the improper use of this equipment by inexperienced or unauthorized individuals.

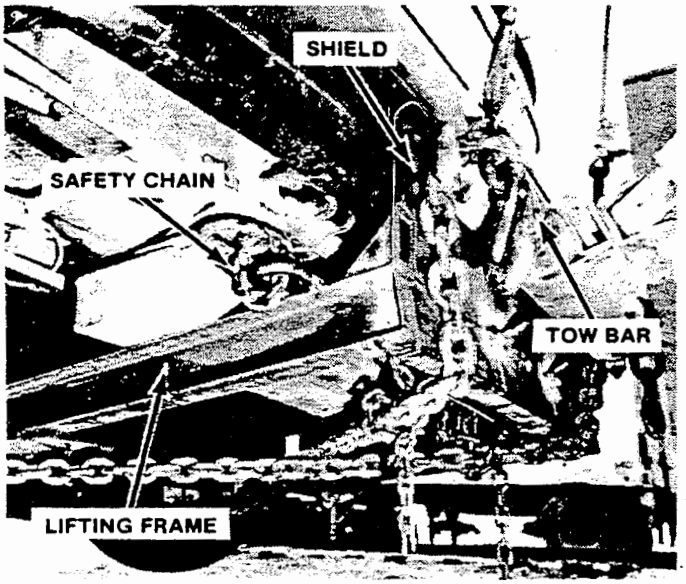


Figure 3-4. Lift Dolly Chain Placement.

To use the frame, you will need to have a hardwood plank for placement between the coach undercarriage and the lifting tool. See figure 3-5. The dimensions of the plank are minimum 4" high × 8" wide × 60" long.

LIFTING PROCEDURE

Read the entire procedure before starting step 1.

1. Remove both drive axle shafts to prevent transmission damage.
2. On three-axle coaches, shut off the trailing axle air valves. They are located inside the right engine side compartment.
3. If the coach engine will not be operating during the tow, attach an external air pressure line, from the tow truck, to the emergency air fill valve in the front service compartment under the driver's floor. The air pressure must be a minimum of 75 psi, and the line should be attached with a clip-on air chuck affixed to the air line.

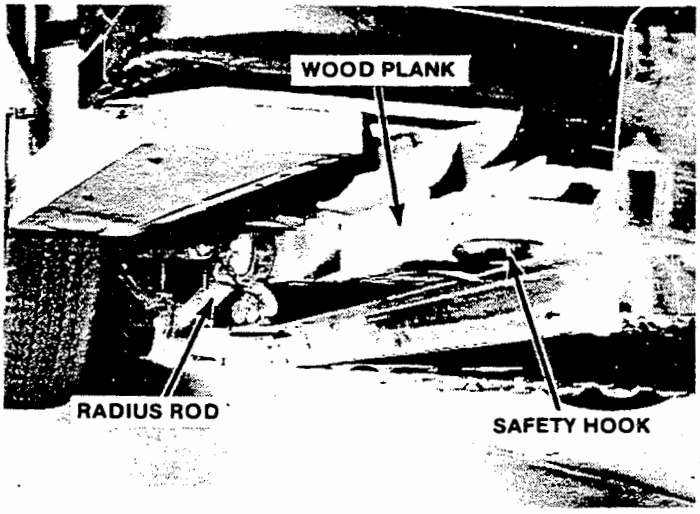


Figure 3-5. Dolly and Plank Position.

CAUTION: Do not tow the coach without external air pressure applied to the emergency air fill if the coach engine will not be operated. Without brake system air pressure, the brakes may apply automatically if system air pressure falls to approximately 40 psi.

4. Spread the tow truck lifting chains under the front area of the coach in an "X" configuration. Approximately two feet of the end of the typical tow truck chain should extend out from under the coach, past the bumper.
5. Roll the lift frame under the coach (over the chains) until the front shield is below, and slightly in front of, the coach bumper. The frame must be laterally centered under the coach center line.
6. Raise the rear of the lift frame until it contacts the coach undercarriage near the front of the radius rods. Support the rear of the frame in this position.
7. As shown in figure 3-5, wrap the tow chains around the radius rods in the following manner:

   a. Bring each chain up through the "D" ring on the lift frame.

b. Wrap the chain around the radius rod from inside to outside.

c. Secure the hook onto the chain, as tight as possible, on the radius rod.

8. Place the hardwood plank on the frame so that when the frame is raised, the plank will contact the tow hooks or eye support area on the coach. If the bus has a retractable step, keep the plank approximately 4" away from the step.

9. Raise the front of the lift frame and locate the shield in front of, and tight against, the bumper. Support the frame in this position. Locate the plank directly under the coach tow eye support.

10. At opposite corners from each radius rod, bring the tow chains up the front of the frame shield and around the lift bar on the tow truck.

CAUTION: Take precautions to eliminate the slack from the chains under the frame before lifting the coach. This will ensure the truck tow bar does not "ride up" over the shield and against the front of the coach.

11. Check that the plank is in proper location against the coach tow eyes. Carefully raise the coach front with the tow truck winch.

12. Place two safety chains at the front of the lift frame as follows:

a. Route each chain down through the tow hook on the coach frame.

b. Bring the chain down the outside, and up through the safety hook on the lift frame.

c. Secure the hook onto the chain to provide a tight attachment.

13. Bring the free end of each safety chain across to the opposite lifting chain. Tighten by using a chain tensioner to eliminate all slack. Make sure the safety chains are tight to prevent side-slip of the lift frame under the coach.

14. Observe the normal precautions including, but not limited to, the ones listed below when towing the coach:

a. Make sure the park brake is released before towing.

b. Do not allow passengers inside the coach during towing.

c. Do not exceed a prudent, safe towing speed. Be aware of changing conditions.

d. Avoid "tight" turning. Accelerate and decelerate slowly, with caution.

e. After approximately two miles towing, check and retighten the safety chains as necessary.

TOWING WITHOUT LIFTING COACH

NOTE: When towing without lifting the coach, use only a tow truck equipped with a standard tow bar and related equipment. All other means of towing are unauthorized.

1. Disconnect both drive axle shafts to prevent damage to the transmission.

2. Operate the coach engine during the tow to maintain brake system air pressure. If the engine cannot be operated, attach an external air pressure line, from the tow truck, to the emergency fill valve in the service compartment under the driver's floor. The air pressure must be 75 psi min., and the line should be attached with a clip-on air chuck affixed to the air line.

3. Position the tow truck so that the truck's tow bar contacts the front bumper of the coach.

4. Attach the tow truck chains in the coach tow eyes and take up all slack.

5. Attach safety chains as applicable.

6. Observe the normal towing precautions including, but not limited to, the ones listed below when towing the coach:

a. Make sure the park brake is released before towing.

b. Do not allow passengers in the coach during towing.

c. Do not exceed a prudent, safe towing speed. Be aware of changing conditions.

d. Avoid "tight" turning. Accelerate and decelerate slowly, with caution.

e. After approximately two miles towing, check and retighten the safety and tow chains as necessary.

COACH JACKING POINTS

When it is necessary to raise the vehicle by using jacks under body members instead of under axles, care should be taken to ensure that pressure is applied only at the points indicated in Figures 3-6 and 3-7; otherwise. distortion or damage may occur to body sections.

CAUTION: On either automatic or manual transmission the drive axle shafts must be removed when being towed to avoid possibility of damage to transmission.

Remove stud nuts and washers retaining axle shafts, rap center of axle shaft flange sharply to loosen dowels and pull out axle shaft. Plug axle tube to prevent oil loss.

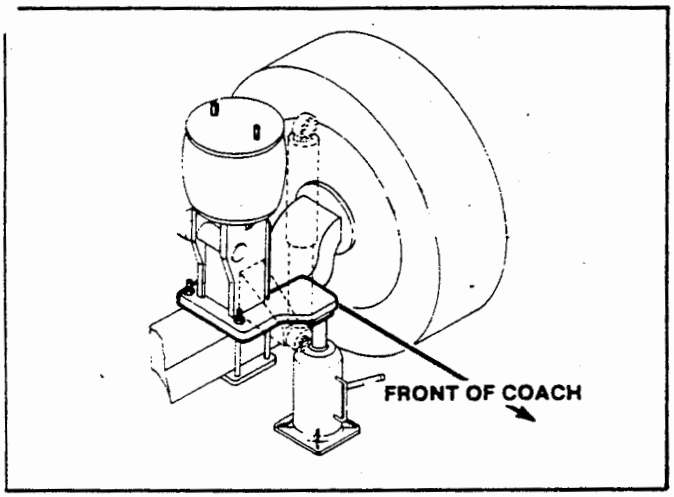


Figure 3-6. Front Jacking Points.

BODY REPAIRS

WELDING

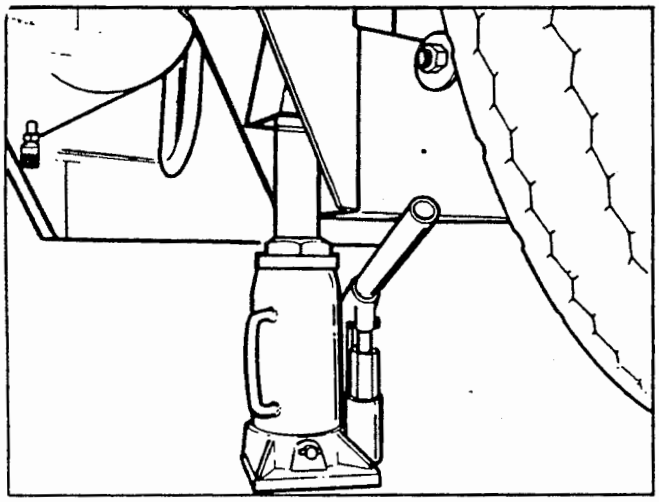
NOTE: Refer to the welding caution in the introductory pages of this manual before starting any welding operation.

The entire frame structure is a welded design. Self-contained suspension bogies for the front and rear are jig welded to ensure proper alignment of the main radius rod attaching points.

All the lower parts of the framework, from the main floor to the skirt rail, are manufactured from stainless steel. This prevents rust and corrosion from occurring on the frame members due to moisture and road salts. The repair of these sections can be carried out in the conventional manner.

The following welding rods should be used when making welding repairs to the body structure:

APPLICATION	DIAM.	A.W.S.
SS to SS or Corten, Light Gauge	3/32" (2.4 mm)	No. 308
SS to SS or Corten, Heavy Gauge	1/8"-5/32" (3.2-4.0 mm)	No. 308
Corten to Corten Light Gauge	3/32"-1/8" (2.4-3.2 mm)	No. 6011
Corten to Corten Heavy Gauge	3/32"-5/32" (2.4-4.0 mm)	No. 7018
Air Beam Reservoirs Heavy Plate Sections	5/32" (4.0 mm)	No. 7018



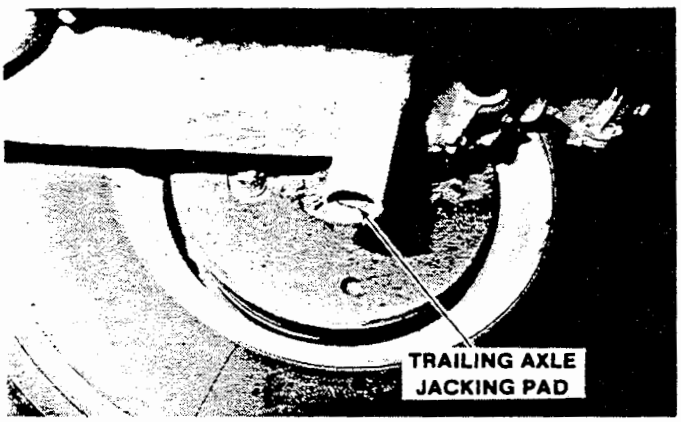


Figure 3-7. Rear Jacking Points.

RIVETING

There are a number of types of rivets used in the manufacture of the coach and a general classification of these types follows:

6053-T6 — used on side paneling, where strength is required and the rivet can be reached for bucking.

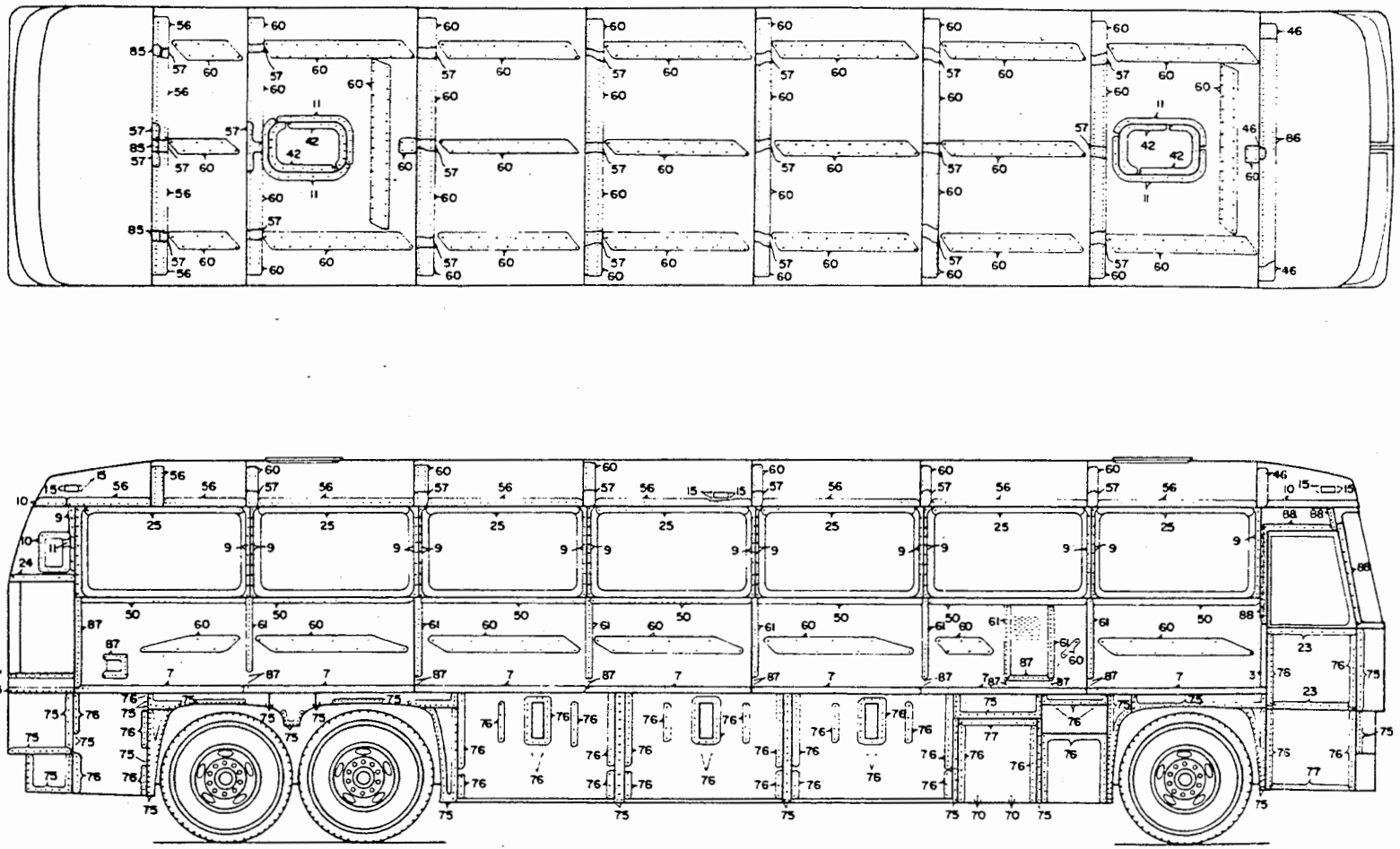
1200 F — used on baggage doors - strength not too critical and can be reached for squeezing.

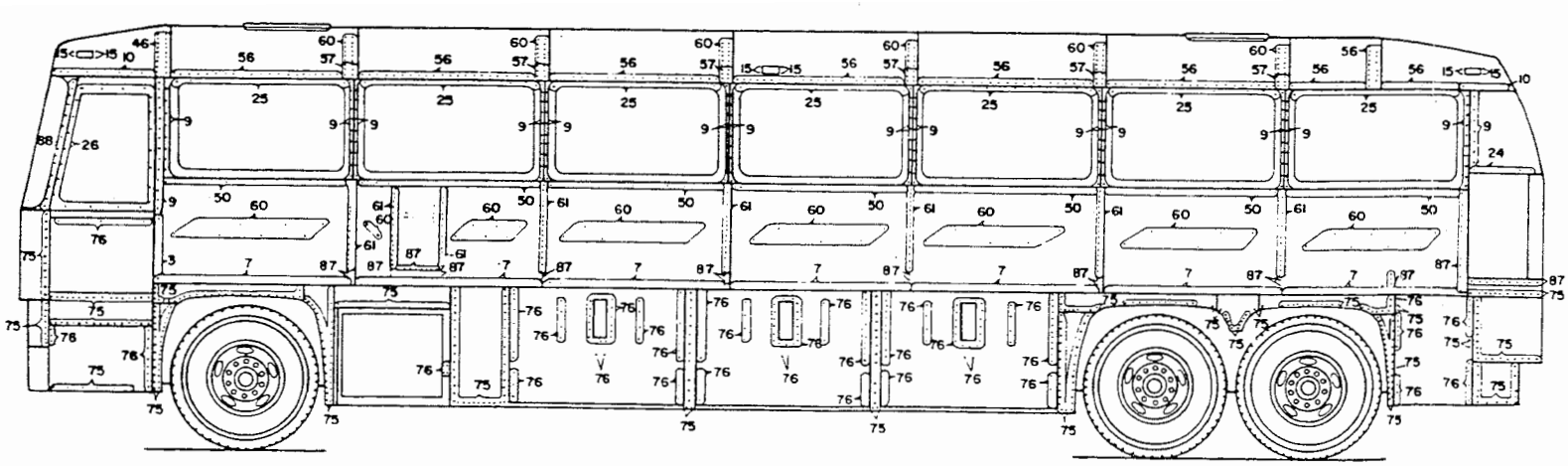
AD-43-BS — U.S.M.C. "Pop" rivets on all other inaccessible points or accessible places where ease of installation is required.

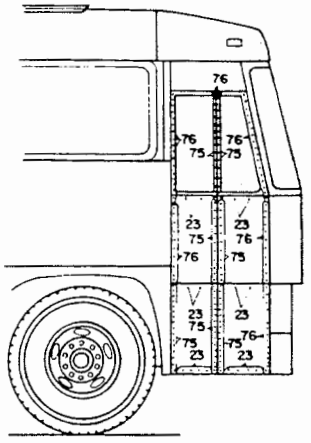
Cherry and Cherry Monobolt — used where strength is required and the rivet is not readily reached for bucking.

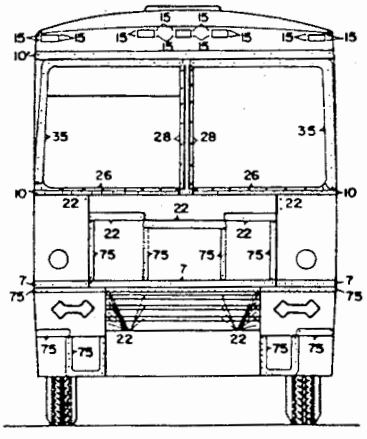
Hand-type guns for pulling up cherry rivets and lazy tongs for Imex and "Pop" are available for repair work. Contact Service Parts department for information.

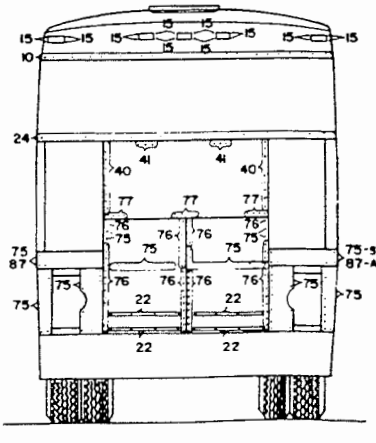
Repairing and replacement of body parts will require removal of rivets. Aluminum rivets can be removed by cutting off the rivet head with a sharp chisel, or by drilling out the rivet with a drill slightly smaller than the body of the rivet. On a rivet with a large head, first cut a groove across the center of the rivet head with a cape chisel, then cut off with a flat chisel. When drilling out pop rivets, always push out the stem first.











KEY NO.	PART NO.	DESCRIPTION
1	19-13-10	Rivet - Cherry, 763W-6-8, 3/16"
3	19-13-12	Rivet - Cherry, 763W-8-6, 1/4"
4	19-13-13	Rivet - Cherry, 763W-8-10, 1/4"
7	19-13-14	Rivet - Cherry,CCR73M-6-4, 3/16"
9	19-13-19	Rivet - Pop, AD66M, 3/16"
10	19-13-22	Rivet - Pop, AD68M, 3/16"
11	19-13-27	Rivet - Pop, AK66M, 3/16"
15	19-13-28	Rivet - Pop, AK440 BS, 1/8"
22	19-13-32	Rivet - Pop, Monel, MD545-BS, 5/32"
23	19-13-33	Rivet - Pop, Monel, MD636-BS, 3/16"
24	19-13-112	Rivet - Pop, Monel, MD650-BS, 3/16"
25	19-13-54	Rivet - 1/8" x 1/4" Fl.Hd. Csk.Al.2SF Cl. Anod.
26	19-13-55	Rivet - 1/8" x 3/8", Fl.Hd. Csk.Al. 2SF Cl. Anod.
28	19-13-58	Rivet - 5/32" x 1/2" Fl.Hd. Csk. Al. 2SF Cl. Anod.
35	19-13-35	Rivet - 1/8" x 3/8", B.Hd. Al. 2SF Cl. Anod.
40	19-13-39	Rivet - 3/16" x 3/8", B.Hd. Al. 2SF Cl. Anod.
41	19-13-40	Rivet - 3/16" x 1/2", B.Hd. Al. 2SF Cl. Anod.
42	19-13-41	Rivet - 3/16" x 5/8", B.Hd. Al. 2SF Cl. Anod.
46	19-13-110	Rivet - 7/32" x 5/8", B.Hd. Al. 2SF Cl. Anod.
50	19-13-66	Rivet - 3/16" x 1/2", U.Hd. Al. 2SF Cl. Anod.
56	19-13-47	Rivet - 7/32" x 1/2", B.Hd. Al. 5SS Cl. Anod.
57	19-13-49	Rivet - 7/32" x 5/8", B.Hd. Al. 5SS Cl. Anod.
60	19-13-44	Rivet - 7/32" x 3/8", B.Hd. Al. 5SST Cl. Anod.
61	19-13-45	Rivet - 7/32" x 1/2", B.Hd. Al. 5SST Cl. Anod.
70	19-13-74	Rivet - 3/16" x 3/8", B.Hd. Semi-Tubular
75	19-13-137	Rivet - Cherry, Pop, CC P-6-4, 3/16" S.S.
76	19-13-138	Rivet - 3/16" x 1/4", T.Hd., Semi-Tubular, S.S.
77	19-13-140	Rivet - 3/16" x 3/8", T.Hd., Semi-Tubular, S.S.
79	19-13-131	Rivet - 3/16" x 1/2", B.Hd. Al. 2SF Black Anod.
80	19-13-143	Rivet - 3/16' x 5/8", B.Hd. Al. 2SF Black Anod.
85	19-13-125	Rivet - 7/32" x 7/8", B.Hd. Al. 5SS Cl. Anod.
86	19-13-152	Rivet - 7/32" x 1/2", B.Hd. Al. 2SF Cl. Anod.
87	19-13-156	Rivet - Cherry "Monobolt" Clear Anod., 1/4" x 3/8"
88	19-13-155	Rivet - Cherry "Monobolt" Black Anod., 1/4" x 3/8" Alum.
89	19-13-168	Rivet - Cherry "Monobolt" 3/16" CCPV-6-4 S.S. Alternative Audel "Monobolt" 2711-0613

EXTERIOR RIVET CHART
MODEL: MC-9

MC-9 MAINTENANCE MANUAL

UPHOLSTERY

Coach seats are lightweight, with foam-padded backs and cushions. Arm rests are provided at both the wall and aisle sides on two passenger seats. Outside back panels are scuff resistant plastic. Removable upholstery covers are standard with vinyl side boxing at headrest areas and woven fabric facings on cushions and backs.

ROUTINE CLEANING

In both appearance and wearability, best results are obtained if upholstery is cleaned at regular intervals before dirt, dust and grit have been ground into the fabric.

All that is required to remove the dirt is a gentle beating with the hand or the back of a brush. This will bring the dirt to the surface where it is easily removed by a vacuum or a soft brush. It is preferable to vacuum or brush in the direction of the pile which can easily be recognized by running a hand lightly over the pile. Cleaning should be carried out as often as possible. If the fabric becomes excessively dirty, particles of grit will cause gradual wear to take place, reducing the life of the fabric.

DRY CLEANING

If covers are to be removed for cleaning, dry cleaning is recommended since washing might cause some shrinkage, preventing the covers from being reapplied to the seats without damage. Stoddard Solvent is recommended as the dry cleaning agent because most covers used on seats are a combination of cloth and vinyl, and this product assures longer vinyl life. Other than spot cleaning, dry cleaning the covers while they are in place is not recommended; the resulting fumes could be hazardous in the confines of the coach and the solvent could be detrimental to the foam padding of the seats.

CLEANING WITH COVERS IN PLACE

The most effective and economical method to clean the woven fabric seat covers is by washing with either an approved foam upholstery cleaner or with a mild household detergent such as *Joy*, *All* or *Tide*.

Follow this procedure when cleaning seat backs and cushions:

1. Thoroughly vacuum clean the upholstery and if spots or stains are to be removed, do so before the seats are washed in order to avoid a "cleaning ring."

2. Dilute household detergent or liquid foam cleaner according to directions on the container, pour a small quantity into a flat pan and work into a thick foam with a sponge or brush.

3. Apply **only** the foam to the fabric using a brush, sponge or turkish towel. Clean only a small area of the fabric at a time with the foam. AVOID SOAKING! Rub vigorously. If the fabric is mohair, brush the dampened surface in the direction of the pile several times with a stiff brush. When dry, brush against the pile to restore the nap.

4. Follow the scrubbing by sponging the suds from the fabric with a clean sponge or a clean cloth moistened with water. Rinse the sponge or cloth often, and change the water when it becomes dirty and/or "sudsy."

5. Before the coach goes back into service, the upholstery should be allowed to dry. To speed up the drying, excess moisture can be blown off the fabric with compressed air.

NOTE: Oil in the air line will soil the fabric. Blow the line clear and test air discharge against a plain white piece of paper. It is also effective to press the edge of a flat stick of hardwood down on the cushion and slowly draw it across the fabric.

Even very soiled areas can be returned to their original appearance by a thorough cleaning. But a regular schedule of cleanings that keeps your upholstery reasonably clean at all times will add months to the service life of coach upholstery.

RECOMMENDED UPHOLSTERY CLEANING SCHEDULE

After the vehicle comes off its regular run, seats should be brushed after the floor of the bus has been swept. A whisk broom is generally used.

NOTE: Maintenance personnel often use sweeping compound to inhibit dust.

Once a week at minimum, the seat cushions and seat backs should be vacuum cleaned. Then the seats should be wiped with a damp, clean cloth to remove any dust or dirt raised to the surface of the fabric but not removed by the vacuum.

At each mechanical check-up during which the vehicle remains in the shop for 24 hours or more, the seat upholstery should be vacuum cleaned, spots removed and then "shampooed."

REMOVAL OF STAINS FROM FABRIC TYPE UPHOLSTERY

CAUTION: Do not use soap, washing powder, ammonia, soda or bleach, nor any cleaning product that contains any of them.

NOTE: Prompt and proper cleaning will remove most stains from coach upholstery. Improper treatment may increase the damage.

Alcoholic liquids — Sponge with water followed by Method 2, below.

Battery acid — Saturate with a solution of Sodium Bicarbonate, leave a few minutes before drying out. It is important for the above treatment to be carried out immediately to avoid serious damage to the fabric.

Beverage stains — Use Method 1, below; if stain persists, try Methylated spirits.

Bloodstains — Use Method 2, below.

Burns — Scrape blackened area with a knife and treat with Method 2, below. Restoration after extensive burns requires attention from a tailor or seamstress.

Chewing gum — Soften with Cyclohexanone and scrape off carefully with a knife.

Cosmetics — Use Method 1, below, followed by Method 2.

Ballpen ink — Treat with Methylated spirits, blotting frequently to avoid ink spreading. Use cleaning Method 2, below, to complete the removal.

Copying ink — Treat same as ballpen ink.

Marking ink (from felt-tipped pens) — Treat with Methyl Ethyl Ketone (MEK) followed by Method 2, below.

Writing ink — Use Method 2, below. If brown stain remains, treat as for rust.

Oil, grease or paint marks — Remove excess substance with a knife or spoon, then treat with Method 1, below, followed by Method 2. If stains reappear, repeat the cleaning process.

Rust — Use Method 2, below, followed by a warm solution of Oxalic Acid and complete treatment by sponging with water.

Tar — Soften with Benzene and then treat with Method 1, below, followed by Method 2.

Urine — Use Method 2.

Vomit and excrement — Use Method 2.

METHOD 1

Apply a nonflammable solvent (Trichloroethylene) with a clean, white, absorbent material. Treat small areas, working from the outer edge toward the center of the stain. Blot frequently with a dry clean cloth to avoid rings.

METHOD 2

Sponge the stain with a solution of household detergent and lukewarm water. Do not soak. Follow this by rubbing with a damp cloth, rinsing the cloth between each treatment.

CLEANING VINYL COVERS AND VINYL TRIM

The vinyl on the seats requires periodic cleaning to retain a neat appearance.

Use only mild household detergents such as No. 409 Cleaner with warm water and apply with a sponge or soft cloth to remove most soiling. In addition, a soft bristle brush may be used after the detergent has been applied to the surface.

CAUTION: Do not use harsh solvent type cleaners such as *Lestoil* or *Fantastic*. Such solvent cleaners cause cracking, crazing and general deterioration of the vinyl and thread materials.

In case of stubborn or embedded dirt, a non-abrasive cleaner such as *Bon Ami* can be effective. Before the surface dries, wipe with a clean, dry cloth to remove residue. This procedure may have to be repeated to remove some stains and dirt.

REMOVAL OF SPOTS AND STAINS FROM VINYL COVERS/TRIM

The following suggestions are often effective in removing the types of stains and spots listed.

- Ink can sometimes be removed by use of alcohol.
- Paint, shoe polish and tar can best be removed by using naphtha or kerosene on a clean white cloth.
- Chewing gum may be removed by first carefully scraping the surface and then using naphtha or kerosene on the remainder.

Do not use any stronger solvents as they will attack vinyl and plastic compositions. After using solvents, wash the vinyl surface with detergent solution and rinse with clean water. Dry with soft, clean cloth.

Badly stained vinyl surfaces can be rejuvenated with *Color Hit*, a flexible color coating made by Advance Color Corporation, 800 South Vail Avenue, P.O. Box 54870, Los Angeles, California 90054. This product is an opaque, water-base coating available in 25 standard colors.

CARPETING

ROUTINE CLEANING

A regular maintenance plan will help you maintain the beautiful appearance of your carpeting for many years. To maintain the best appearance level possible, follow the basic maintenance plan below.

CAUTION: Do not use soap, washing powder, ammonia, soda or bleach. Prompt cleaning will remove most stains. Improper treatment may increase the damage.

Light vacuuming or carpet sweeping is usually needed daily in heavy traffic areas. This is to pick up most surface dust, lint and soil. Carpet sweeper or cannister type vacuums work well for quick cleaning.

A vacuum equipped with a beater bar or a very high air velocity commercial vacuum is needed for thorough vacuuming. The beater agitates the pile to free abrasive dirt particles buried below the surface. Move the vacuum slowly to give the dirt time to be shaken loose and drawn up by the vacuum.

Commercial cleaning of the carpet is recommended each year, depending on conditions, for those who want the best appearance and longest life from their carpet.

STAIN REMOVAL

The following materials can be readily obtained for use in a spot removal kit. Bottle and label them for future use.

Dry cleaning fluid (nonflammable such as Perchlorethylene).

Detergent solution — mix one teaspoon (5 ml) of neutral powder type of detergent in ½ pint (280 ml) of water.

Solution to neutralize acid stains (fruit juices). Mix one tablespoon (15 ml) ammonia to ¾ cup (177 ml) of water.

Solution to neutralize alkaline stains (bleach, wine, urine). Mix 1/3 cup (79 ml) of white vinegar with 2/3 cup (157 ml) of water.

Can of Freon 12, if needed (available at refrigeration outlets).

Clean, white absorbent cloths, a sponge, an eyedropper.

Alcohol — Detergent solution.

Ballpoint Ink — Dry cleaning fluid.

Beer — Detergent solution followed by small amount of vinegar.

Blood — Detergent solution followed by ammonia solution, then vinegar solution and a dry cleaning fluid after spot is dry.

Butter - Dry cleaning fluid.

Candy — See section on "Difficult Stains."

Carbon Black — Detergent solution.

Chocolate — Apply dry cleaning fluid followed by detergent solution.

Coffee — Detergent solution.

Cosmetics — Dry cleaning fluid (except lipstick).

Crayon — Dry cleaning fluid.

Crepe Paper — Detergent solution.

Egg — Treat as for chocolate.

Excrement — Remove all solids, then treat as for beer.

Food Color — Detergent solution.

Food Stains — Remove all solids, then treat as for chocolate.
Fruit Juice — Detergent solution followed by ammonia solution.
Gelatin — Detergent solution.
Glue — Detergent solution.
Grass — Treat as for chocolate.
Gravy — Treat as for chocolate.
Grease — Dry cleaning fluid.
Gum — See section on "Difficult Stains."
House Cement — Dry cleaning fluid.
Ice Cream — Detergent solution.
Iodine — Detergent solution.
Ketchup — Detergent solution.
Metal Polish — Dry cleaning fluid.
Milk — Treat as for chocolate.
Mustard — Detergent solution.
Nail Polish — See "Difficult Stains."
Oils — Dry cleaning fluid.
Permanent Ink — Detergent solution.
Rust — See "Difficult Stains."
Shoe Polish — Dry cleaning fluid.
Soft Drinks — Detergent solution.
Soot — Detergent solution.
Tar — Dry cleaning fluid.
Tea — Detergent solution.
Toothpaste — Detergent solution.
Urine — See "Difficult Stains."
Vaseline — Dry cleaning fluid.
Vomit — Remove all solids, then treat with detergent solution.
Water Colors — Detergent solution followed by ammonia solution.
Wax — Dry cleaning fluid.
Wine — Detergent solution followed by vinegar solution.

DIFFICULT STAINS

CANDY — Use the stain removal method for chocolate but apply the vinegar solution and then water once the stain is removed.

GUM — Easily removed by quick freezing it with dry ice or a freon aerosol spray and hitting it sharply with a hammer or hard instrument. Then scrape it off and remove any residue with dry cleaning solvent.

NAIL POLISH — Can be satisfactorily removed with nail polish remover, but it can seriously damage any carpet containing acetate fibers. Test it first sparingly in some inconspicuous area of the carpet and, should the color run, contact a professional cleaner for assistance.

STRONG ACIDS — Such as carbolic acid disinfectant and some tile cleaning compounds require drastic and immediate action to prevent serious damage. Quickly flush the affected area with water. Sponge up excess water, and repeat several times to dilute acid and wash it away. Sponge the area with ammonia solution and rinse again. Be sure to dry the carpet as quickly and thoroughly as possible, using a fan or vacuum cleaner.

STRONG ALKALIES — Such as lye, caustic soda, oven cleaner and paint cleaner can cause serious damage. Immediate attention is essential. Quickly flush the affected area with water as described under "Strong Acids." Then sponge area with vinegar solution and rinse again. Dry the carpet as in "Strong Acids."

URINE — Absorb all liquid with a tissue or paper towel. Work (do not rub) a neutral detergent into stain and repeat. Apply one part white vinegar to two parts water and work (do not rub) into yarns. Allow it to set and then absorb excess liquid. Place absorbent material on top and weigh it down (books, etc.) and leave for six to eight hours to dry.

UNKNOWN STAINS — If they are "set" or are not identifiable, try detergent and water first. If this does not work, let stain dry and then try dry cleaning fluid. If this does not remove the stain, contact a professional carpet cleaner for assistance.

DRIVER'S AND PASSENGER'S MODESTY PANELS

The modesty panels are made of fiberglass with a smooth, easily cleaned gel-coat finish.

Cleaning with mild detergent and water will remove most surface soiling. Tar, gum, etc., may be removed with a solvent such as kerosene. Volatile solvents, such as acetone, are not recommended. After using a solvent, clean the area with mild detergent and water.

DRIVER'S ACRYLIC GUARD PANEL

An acrylic panel is mounted above the driver's modesty panel. Care should be taken when cleaning it.

The panel should first be dusted very lightly (not wiped) with a soft, clean cloth. The surface can then be wiped carefully with a soft, wet cloth or chamois. The cloth or chamois should be kept free of grit by rinsing it often in clean water. A mild dishwashing detergent may be used if necessary.

Grease and oil may be removed with hexane, kerosene, or aliphatic naphtha (no aromatic content).

CAUTION: Do not use solvents such as acetone, benzene, carbon tetrachloride, fire extinguisher fluid, dry cleaning fluid, or lacquer thinners, since they soften and distort acrylic material. Do not use window sprays or kitchen scouring compounds.

If, after washing, the surface shows minor scratches, most of them can be removed or reduced by hand polishing. The polishes can be best applied with a small pad of soft cotton flannel which has been dampened with water. Rub the panel in a straight to-and-fro motion parallel with the light scratches to be removed, or with a circular motion. Excessive rubbing at one spot should be avoided. Several applications may be necessary, but most minor scratches can be reduced and clarity improved within a relatively short time.

After the scratches are removed or reduced, the cleaner should be removed with a clean, soft cloth.

VINYL REPAIR

Remove existing damaged vinyl covering from metal panel. Thoroughly clean the panel. Use a toluene cleaning fluid. Apply a coat of No. 1368 3M contact cement to panel and bottom side of vinyl. Allow cement to dry until tack-free before applying vinyl to panel.

NOTE: Cement must be sprayed on smoothly. If spraying equipment is not available, the cement can be brushed on; however, application must be thin, uniform and smooth.

1. Apply masking tape around the outside area of the precise area to be covered by the patch. Using medium grit (120) sandpaper on a sanding block, thoroughly abrade the entire area that is to be covered. Wipe all residue off the surface with a tack-rag or with a clean cloth dampened with isopropyl alcohol. Spray or brush a thin, uniform DI-NOC brand primer 8004 on the surface and allow to dry for approximately 15 minutes. Remove all masking tape before the primer dries.

2. Cut the patch of 3M vinyl to the precise size of the area to be covered. Oversized patches will not adequately adhere to the unprimed edges and undersized pieces will leave non-coated areas of film which would be susceptible to staining and discoloration.

3. To remove the liner, place the vinyl face down on a clean, flat surface, hold firmly and remove the liner or backing with a smooth 180° motion. During hot or humid weather a slight jerking motion will aid in the liner or backing removal.

NOTE: Always remove the liner or backing from the vinyl; never the vinyl from the liner or backing as vinyl stretching may result.

4. Cut the liner or backing into two pieces (about 1/3 and 2/3 of its original size). Do not cut the vinyl. See figure 3-8. Place patch face down on a flat surface. Peel back and cut off approximately 1/3 from one edge.

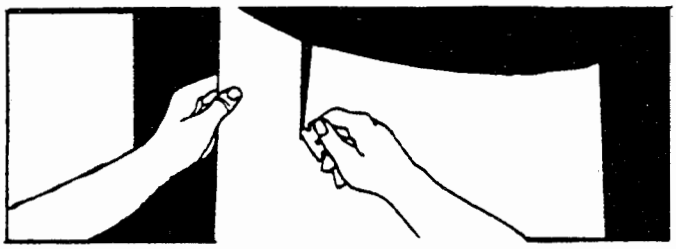


Figure 3-8. Cutting Liner or Backing.

5. Replace the two liner or backing pieces on the vinyl (adhesive side), leaving a gap of one to two inches between the two pieces (figure 3-9). Replace liner paper on adhesive, plastic side down, exposing about 1-2" (25.4-50.8 mm) of adhesive.

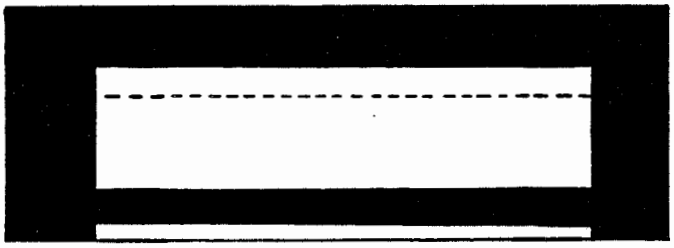


Figure 3-9. Replacing Lining Paper.

6. Use plastic applicator to burnish the exposed section of the vinyl. Use firm, overlapping strokes working from the center to the edge. This section will now act as a hinge when applying the rest of the vinyl. Apply marking along line of exposed adhesive. This will now act as a hinge.

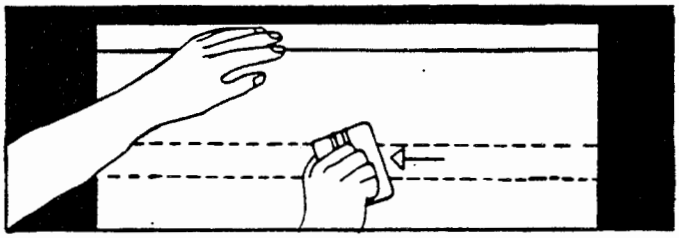


Figure 3-10. Burnishing Vinyl.

7. Lift the smaller (1/3) section of the vinyl and remove the liner or backing as you "squeegee" with firm, overlapping strokes. Repeat with larger (2/3) section. Go over all edges to ensure that they are firmly adhered. See figure 3-10.

CLEAN-UP

Use a clean cloth dampened with either MEK (Methyl Ethyl Ketone) or lacquer thinner to clean up any residual adhesive which may have oozed out from beneath the vinyl.

WARNING: DI-NOC brand Primer 8004, MEK (Methyl Ethyl Ketone) and lacquer thinner are flammable liquids. Use only in well ventilated areas away from flames or sparks. Do not soak the vinyl with these materials.

ALTERNATE METHOD OF VINYL REPAIR

A vinyl repair product is available from Advance Color Corporation, 800 South Vail Avenue, P.O. Box 54870, Los Angeles, California 90054. This product, called *Instant Vinyl,* is used for repairing cuts, tears, cigarette burn holes and the like in any vinyl upholstery material. *Instant Vinyl* is a clear, jelly-like substance which acts as a bond between the edges of the original vinyl and, in effect, replaces vinyl, providing a smooth and completely flexible seam or weld.

REPLACEMENT OF FLOOR COVERING

1. Remove existing damaged floor covering from wood floor. Thoroughly clean the floor by wire brushing or sanding.

2. Remove all sanding dust and other foreign matter. Floor must be clean before applying adhesive.

3. Under passenger seats, on center aisle, driver's area and entrance area, apply a coat of Armstrong Lino Cement No. SP235 (M.C.I. Part No. 19-16-353) adhesive to plywood floor. Vinyl covering can be applied immediately.

IMRON PAINT

If sheet metal parts are purchased from Universal Coach Parts Inc., Northlake, Illinois and in Canada from Motor Coach Industries, Service Parts Division, they will be forwarded in a primed condition. It is then only necessary to apply finish coats as outlined.

MCI model coaches are painted with Dupont Imron paint. Instructions on painting with Imron follow.

This high gloss polyurethane enamel finish is designed for exposure to extreme conditions. The 2-package product is

comprised of a pigmented base and an activator. Companion products include an optional dry-time accelerator, an additive to eliminate fish-eyes, and a reducer.

The following specifications cover refinishing of both bare metals and fiberglass as well as painted metals and fiberglass.

Care should be exercised in storing, handling, mixing and applying Imron paint and Imron chemical materials listed in this manual. The topcoat, primer, solvent, catalysts, accelerators, activators and cleaners are highly volatile and/or toxic. In addition to observing the safety instructions listed on the packaging, the following safety precautions should be observed.

A. No smoking in the paint room or any adjacent area exposed to residue fumes.

B. Only NIOSH (National Institute for Occupational Safety and Health) approved respirators should be used.

C. Adequate ventilation must be maintained.

D. Wash hands prior to eating.

E. Wear rubber gloves, rubber apron, and face shield during all phases of paint and chemical handling.

F. If available, operator supplied air (Independent Breathing Apparatus) should be used.

Activator — Imron must be activated with 192S Activator. Ratio: One part 192S Activator to three parts Imron. Mix thoroughly.

Additives - 189S Dry-Time Accelerator — to be used for faster tape-free time. Ratio: up to four ounces of 189S to one gallon of mixed Imron.

259S Fish Eye Eliminator — when necessary, use to eliminate fish eyes. Use up to two ounces per gallon.

Reducers — 8485S used to reduce Imron to a viscosity of 18-22 seconds in a Dupont M-50 Viscosity Cup. 8100S used as an Imron retarder.

Air Pressure — 50 psi "at the gun" for solid colors; 65 psi "at the gun" for metallic colors.

Application — for solid colors (non-metallic), spray a medium first coat. Allow to become tacky and follow with a full second coat. For metallic colors, spray three light to medium coats. After hiding has been achieved, reduce activated Imron 15% with 8485S Imron Reducer. Apply one or two mist coats to improve flow out and reduce mottling.

Two-Toning — at 77°F (25°C) and 50 percent humidity, two-toning can be done in six to ten hours. If 189S Accelerator is used, two-toning can be done in two to four hours minimum at 70-75°F (21-24°C).

CAUTION: Clean all equipment with 3602S Lacquer Thinner or 8485S Reducer immediately after use.

DECAL APPLICATION

The following drying times should be observed to prevent blistering when applying decals over Imron paint. Overnight drying following 30 minutes drying at 180°F (82°C), 60 minutes drying at 140°F (60°C) or 120 minutes drying at 110°F (43°C). If sufficient time and temperature is allowed in the cure of the Imron, it is possible to apply decals to the Imron surface without experiencing the blistering effect.

NOTE: Allow wheel hubs to come to room temperature prior to painting so a condensate does not appear causing lack of adhesion of paint.

When painting the flat black area on stainless steel sections of radiator and blower doors, treat these parts with Red Corlar primer 825S. The same procedure can be used on the fiberglass window panes on the side of the coach.

STEEL

1. Surface Preparation — Wash with 3812S Enamel Reducer and wipe dry with clean cloths.
2. Apply 5717S Metal Conditioner — In a plastic container, mix 5717S Metal Conditioner with two parts water and apply to the surface with a cloth or sponge; if rust or corrosion is present, use a Scotch-Brite or similar abrasive pad. While still wet, wipe dry with clean cloths.
3. Apply 224S Conversion Coating — In a palstic container and without dilution, use a Scotch-Brite or similar pad and apply to the treated metal surface. Leave on the surface two to five minutes. Work only as much area as can be coated and rinsed before the solution dries. Reapply if surface dries before rinsing. Rinse by flushing the surface with cold water or mop with a damp sponge or cloth rinsed occasionally in clean water. Wipe dry with clean cloths or air dry. Apply primer.
4. Apply 825S Corlar Epoxy Primer.

STAINLESS STEEL

1. Surface Preparation — Wash with 3812S Enamel Reducer and wipe dry with clean cloths. Fine particle sand blast or sand well.
2. Apply 5717S Metal Conditioner — In a plastic container, mix 5717S Metal Conditioner with two parts water and apply to the surface with a cloth or sponge; if corrosion is present, use a Scotch-Brite or similar abrasive pad. While still wet, dry with clean cloths.
3. Apply 224S Conversion Coating — In a plastic container and without dilution, use a Scotch-Brite or similar pad and apply to the treated metal surface. Leave on the surface two to five minutes. Work only as much area as can be coated and rinsed before the solution dries. Reapply if surface dries before rinsing. Rinse by flushing the surface with cold water or mop with a damp sponge or cloth rinsed occasionally in clean water. Wipe dry with clean cloths or air dry. Apply primer.
4. Apply 825S Corlar Epoxy Primer.

ALUMINUM

1. Surface Preparation — Wash with 3812S Enamel Reducer and wipe dry with clean cloths.
2. Apply 225S Aluminum Cleaner — In a plastic container, mix 225S Aluminum Cleaner with two parts water and apply to the surface with a cloth or sponge; if rust or corrosion is present, use a Scotch-Brite or similar abrasive pad. While still wet, wipe dry with clean cloths.

3. Apply 226S Conversion Coating — In a plastic container and without dilution, use a Scotch-Brite or similar pad and apply to the treated metal surface. Leave on the surface two to five minutes. Work only as much area as can be coated and rinsed before the solution dries. Reapply if surface dries before rinsing. Rinse by flushing the surface with cold water or mop with a damp sponge or cloth rinsed occasionally in clean water. Wipe dry with clean cloths or air dry. Apply primer.

4. Apply 824S/825S Epoxy Primer.

FIBERGLASS PANELS

1. Surface Preparation — Wash the surface with 3819S PrepSol. While still wet, wipe dry with clean cloths.

2. Sand thoroughly, clean and apply 824S/825S Corlar Epoxy Primer.

PRIMING STEEL, STAINLESS STEEL, ALUMINUM, FIBERGLASS

825S Corlar Epoxy Primer (red) is our recommendation for steel, stainless steel and aluminum. 824S Corlar Primer (gray) is our recommendation for fiberglass and may also be used on aluminum.

Activation — to two parts 824S/825S Primer, and one part 826S Activator.

Induction Period — allow activated primer to stand one hour at 70°F (21°C) and above; two hours when temperature is below 70°F (21°C). This will allow the chemical reaction to take place.

Pot Life — three days at 70°F (21°C).

Reduction — reduce activated primer 33-1/3 percent by volume (ratio 3 to 1) with 3602S Lacquer Thinner to a viscosity of 21-24 sec. in a Dupont M-50 Viscosity Cup or equivalent.

Application — Using 45-55 psi "at the gun," spray one full wet coat to give a dry film thickness of 0.7 to 1.0 mils.

Drying Time — two to six hours depending on temperature and film thickness. Overnight dry may be necessary when 2 or 3 coats have been applied and/or when temperatures are low.

PRIMING PREVIOUSLY PAINTED STEEL, STAINLESS STEEL, ALUMINUM, FIBERGLASS

1. Wash the painted surfaces with soap and water to remove dirt and water-soluble contaminants.

2. Wipe the painted surfaces with 3919S Prep-Sol to remove wax, grease and other contaminants. While solvent is wet, wipe dry.

3. Repair flaws in the painted surface by grinding off paint in the damaged areas and fill in body filler, if necessary. Featheredge ground-off areas by machine or hand sanding. Treat bare metal areas with the appropriate conditions and conversion coatings.

4. Apply 824S, 825S, 100S or 110S as recommended above. Prime as follows:

825S Corlar Epoxy Primer (red) is our recommendation for priming or spot priming previously painted surfaces where the metal substrate is steel, stainless steel or aluminum. 824S -Corlar Epoxy Primer (gray) is our recommendation for priming or spot priming previously painted surfaces where the substrate is fiberglass (can also be used on aluminum).

Activation — to two parts 824S/825S Primer, add one part 826S Activator.

Induction Period — allow activated primer to stand one hour at 70°F (21°C) and above; two hours when temperature is below 70°F (21°C). This will allow the chemical reaction to take place.

Pot Life — three days at 70°F (21°C).

Reduction — For spot repairs, reduce the activated primer 20 percent by volume (ratio 5 to 1) with 3602S Lacquer Thinner.

Application — using 45-55 psi "at the gun," spray until satisfactory filling is achieved (2 to 4 coats).

Drying Time — with this heavier mixture, drying time will be extended to four to eight hours and overnight dry may be necessary.

SPOT PRIMING

100S Gray/110S Red Oxide Multi-Purpose Acrylic Lacquer Primer may be used as an alternate priming system for making spot repairs on small bare metal areas. Metal to be treated as described above.

Reduction — 80 to 125 percent by volume (ratio 1 to 1) to a viscosity of 23-24 sec. on a Dupont M-50 Viscosity Cup or equivalent with 3661S Lacquer Thinner in the the mid-temp ranges and 3602S Lacquer Thinner during warm weather.

Application — using 35-45 psi "at the gun," spray three or more coats as needed. Allow each coat to completely flash.

Drying Time — allow to dry thoroughly before sanding — 30 to 60 minutes.

FIBERGLASS REPAIRS

All repairs to fiberglass parts consist of filling the damaged area with fiberglass cloth and resin or strand fiberglass and resin. The repair is allowed to harden and then the finishing operations are performed. Use of the various materials is determined by the type of repair to be made. Large holes, torn sections and separated joints require the adhesive qualities of the resin and the reinforcing qualities of the fiberglass. Small dents, scratches or pits can be repaired using resin, strand fiberglass and filler mixed into paste. Instructions for either mix are explained later.

The following additional tools and materials will assist in making repairs. Hacksaw blade, assorted files, emery paper or cloth (No. 150 grit or finer), scissors or tin snips, wax paper or cellophane sheets, small 3" (76.2 mm) paint roller, paint brush, putty knife, acetone and one or more heat lamps.

For best results the ambient temperature should be 70° to 75°F (21-24°C) when making repairs.

CAUTION: Some people experience a skin reaction to resins. If this happens, wipe off skin with denatured alcohol or clean thinner. There are several protective hand creams available and their use is recommended.

If any disc grinding or sanding is to be done in an enclosed area, a respirator should be used and goggles should be worn.

Extreme care must be taken if the sander is electrically operated as dust of some resins is combustible when subjected to sparks or open flame. The proper tool for sanding resin is a low speed, air driven disc sander with a water attachment or a dry sander having a vacuum bag attachment. Either will eliminate fiberglass and resin dust.

FIBERGLASS CLOTH PROCEDURE.

1. Remove all loose particles or damaged material using a power sander or rasp and where necessary sand paint away. On underside of coach scrape undercoating off and wipe clean with solvent. Remove all dirt, grease and paint to 1½" around damaged area and feather the cleaned area all around.

2. Grind or file the damaged area to form a "V" at the broken or cracked portion. Sides of the "V" should have a shallow pitch for maximum bonding area.

NOTE: Roughening the surface improves adhesion of resin.

3. If paneling is warped, use C clamps and improved clamp plates to align surfaces. Preheat area to be repaired using one or two heat lamps positioned 12 to 15 inches (305-381 mm) from repair area.

CAUTION: 200°F (93°C) is the high limit for this material. To go higher is to risk material distortion or crystallizing.

4. Cut a piece of fiberglass one to three inches larger than the area to be repaired and impregnate with general purpose polyester resin catalyzed normally. Mix the desired quantity of resin and hardener in proportions of ½ tablespoon hardener to one quart resin. Do not use wax cups for mixing and prevent contamination between resin and hardener cans. A thin mixture can be thickened by adding powdered filler.

5. Use a clean paint brush to apply the resin placing the impregnated mat over the hole and pressing onto the surface with the brush to obtain good adherence. Another coat of resin may be applied at this time. Alternate layers of mat and cloth saturating each layer of fiberglass as it is placed over the damaged area. Smooth out the wrinkles while ensuring that the general contour of the area is maintained. Bubbles and wrinkles an be rolled out using a roller.

6. When the required strength and thickness is obtained (two 1½ oz. [52.5 g] mats and one 9 oz. [255 g] cloth), allow the area to harden. Allow sufficient time for the patch to cool off properly before proceeding.

NOTE: Be sure all air is removed from between surfaces being joined.

CAUTION: Once the resin and hardener have been mixed, the pot life (working time) of the mix is approximately 15 minutes. Any accidental contamination to the skin, clothing, tools, etc., must be removed within this period. Use acetone to remove uncured resin.

7. Heat resin material again placing lamps 12 to 15 inches (305-381 mm) from repaired area. Allow 12 to 15 minutes for repair to cure.

8. After repair is cured, grind, file or sand to contour. Files other than body files may be more suitable. Feather edge and finish sanding.

9. After rough sanding, small pits or irregularities may appear in the finished surface. Repair following the instructions under Fiberglass Paste Repairs. Smooth off the surface with 100 sandpaper and finish with 120 sandpaper. Reprime and repaint according to appropriate painting instructions.

FIBERGLASS PASTE REPAIRS

A fiberglass paste is used for repairing small dents, scratches, and pits. The paste is made by mixing resin, hardener and fiberglass strand or filler to the consistency of putty.

1. Where necessary, sand paint away around damaged area. On underside of coach, scrape away undercoating from damaged area and wipe clean with solvent.

2. Preheat the area to be repaired using heat lamps. Mix desired quantity of resin and hardener (refer to manufacturer's instructions on container). Add powdered fiberglass strand into mixture to thicken it into a putty state.

CAUTION: If repair is to be made on a vertical surface, adding of powdered filler material to mixture will reduce tendency of hot resin to flow or run.

3. Apply the material with a putty knife or similar object, building material up to desired contour. For deep filling and on vertical surfaces several layers of material may be needed.

4. A hacksaw blade held flat to adjacent contour and then pulled, using sawing action across repair when the resin is in the jell stage will remove excess resin from repair.

5. Finish repair in the same manner as when using fiberglass cloth.

FIBERGLASS ROOF PANEL REPLACEMENT

Should replacement of a complete fiberglass roof panel assembly be required, it is recommended that the panel be fitted to the roof section and marked from the underside in the areas where the roof bows are located.

1. If the roof bow channels are bent or damaged, they should be altered or replaced in order to match the contours of the

fiberglass panel. Some areas may required shims. The location and necessary thickness for each shim should also be marked for required additions.

2. The panel should then be removed and sanded in the marked areas in order to roughen the mounting surfaces. Apply Dolphinite sealer to the channel mounting surface and the sanded area of the fiberglass panel. Place and clamp panels in place complete with any necessary shims. Inspect the panel for proper fitting.

3. Drill holes through the panel from the underside of the channel. Existing holes in the roof bow channel may be used as a template.

NOTE: Only drill four to five holes at one time. Do not attempt to drill all the holes and then rivet. Prior to riveting, check to ensure that misalignment and gapping have not occurred.

WINDOWS

DESCRIPTION

Seven passenger side windows are provided on each side of the coach. They are fixed, single glazed, heat absorbing AS-3 laminated float safety glass mounted in black anodized extruded aluminum frames. Stainless steel sash hinges with phosphor bronze removable pins are mounted on the top. The sash may be pushed out for emergency escape by lifting the aluminum release bar at the lower edge which disengages the safety latches. Emergency operating instructions on metal plates are attached to the release bars at each seat location. All side window glass is interchangeable. Double glazed sashes are available and as well "Lucite" SAR acrylic sheet is available as an option with single glazing only. See washing for correct washing procedure for "Lucite" windows.

The side windows are readily removed once the window is in the emergency release position. Remove the snap rings from each end of the hinge pin, then remove the pins from the hinges. Push out at top of sash and lower window assembly from opening.

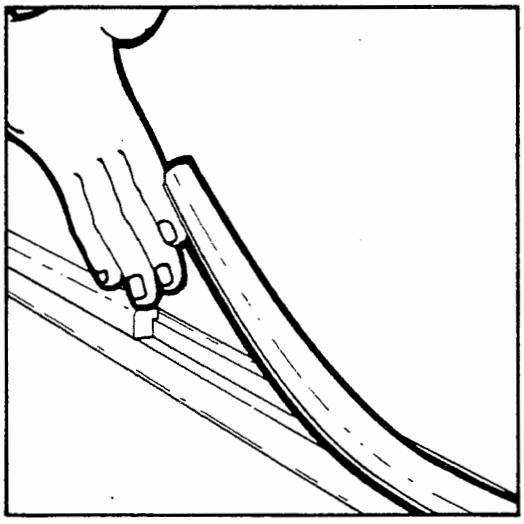


Figure 3-11. Removing Retaining Rubber.

TO REPLACE GLASS

Remove the retaining rubber around the glass from the interior side of the frame. Find the spot where the two ends of the retaining rubber meet and pry one end up as shown in photo. Once the retaining rubber is removed, the glass can be pushed out of the frame. After replacing glass, place the ends of the retaining rubber at the middle of the frame and press down tightly. Work your way around the glass pressing the retaining rubber down tightly until it is in place.

Access to the window frame mounting hinges may be gained from the exterior of the coach by lifting the rubber molding. When re-installing the assembly, the protective molding Imust be sealed in place with a quality rubber cement.

NOTE: During removal and installation of side sash assembly, care should be taken to ensure proper placement of all window components. Weatherstripping, exterior molding, etc., cannot be reinstalled once cut or damaged.

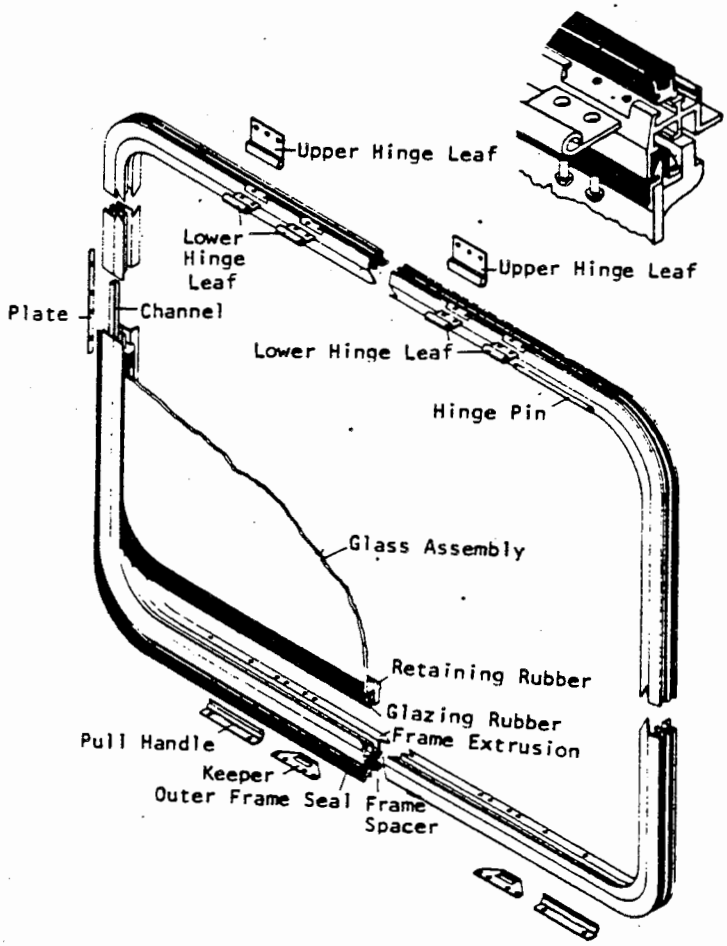


Figure 3-12. Side Window Installation.

MC-9 MAINTENANCE MANUAL

REAR WINDOW

A one-piece, color-impregnated, molded, reinforced fiberglass panel is riveted to the main structure. The panel is insulated with a 2" (51 mm) fiberglass blanket.

Sash assembly complete with hinge and retainer may be removed by removing the screws attaching the hinge retainer to the body.

DRIVER'S WINDOW

A single-glazed, fixed, one-piece, full-vision-type driver's window is provided with anodized aluminum frame. A small sliding section for signaling and mirror adjustment is provided at the lower rear corner. An optional double-glazed, one-piece driver's window with a small sliding section is also available. Window glass is AS-2 laminated safety glass with a 9-inch mask applied to the top portion of the window.

NOTE: During removal and installation of the driver's window, care should be taken to ensure proper placement of all window components. Weatherstripping, wear plates, etc., are not shown in the assembly drawing, but their locations may be determined from the MC-9 Parts Manual.

WINDSHIELDS

DESCRIPTION

Two large curved windshields of AS-1 laminated safety glass provide an unmasked area of 43½" × 26" (1105 mm × 660 mm). They are interchangeable from either side. The windshields are laced to a flange around the opening by means of a one-piece black rubber extrusion and rubber filler strip.

WINDSHIELD INSTALLATION

Windshield installation must be performed by more than one person. refer to figure 3-13.

1. Apply butyl tape to lip of windshield frame opening.
2. Install weatherstrip into opening.
3. Apply Glass-Slip or equivalent into the weatherstrip channel.
4. Using wooden or plastic tool, tuck glass into weatherstrip. Begin at top corner of windshield post and work around.
5. Seal glass perimeter approximately 12" each direction from each corner with E-708C black (Protective Treatment, Inc.) sealant or equivalent.
6. Apply soap solution to the lacing and, using a windshield lacing tool, install lacing into the groove.

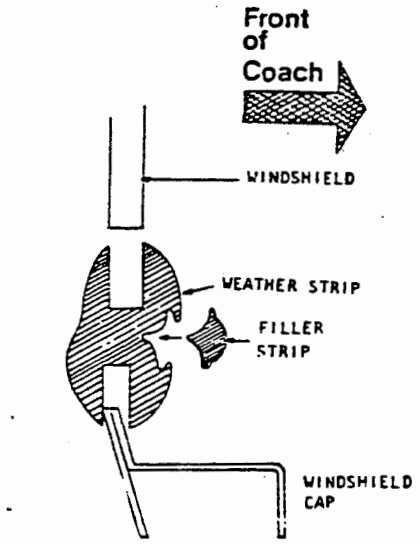


Figure 3-13. Windshield Cross-section.

MC-9 MAINTENANCE MANUAL

DRIVER'S WINDOW ASSEMBLY

A single glazed, fixed, one-piece driver's window is provided with anodized aluminum frame (figure 3-14). A small sliding section for signaling and mirror adjustment is provided at the lower rear corner.

The driver's window is removed by first removing all screws from the interior retaining frame. Then remove the glass from the rubber retainer.

NOTE: During removal and installation of the driver's window, care should be taken to ensure proper placement of all window components.

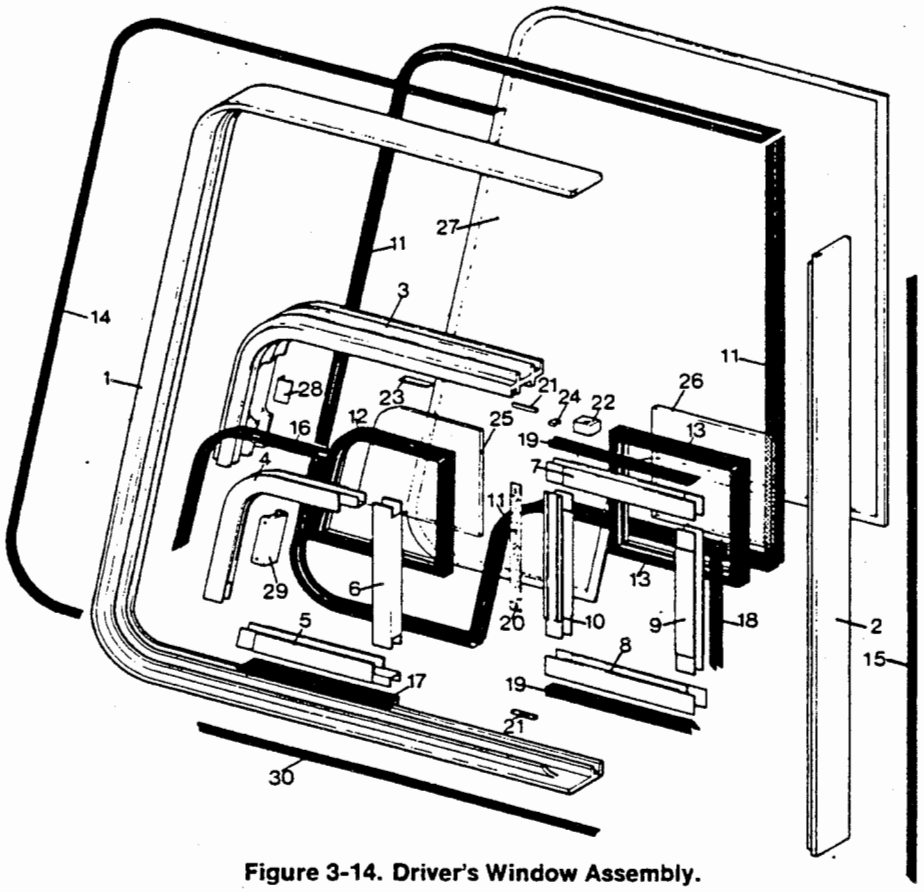


Figure 3-14. Driver's Window Assembly.

1. Front Frame Rail
2. Rear Frame Rail
3. Curved Inside Frame Rail
4. Curved Sliding Rail
5. Bottom Sliding Rail
6. Side Sliding Rail
7. Top Stationary Rail
8. Bottom Stationary Rail
9. Rear Side Stationary Rail
10. Front Side Stationary Rail
11. Main Unit Rubber Glazing
12. Slider Rubber Glazing
13. Stationary Rubber Glazing
14. Front Rubber Seal
15. Side Rubber Seal
16. Curved Weatherstrip
17. Bottom Weatherstrip
18. Side Weatherstrip
19. Top & Bottom Weatherstrip
20. Weatherstrip
21. Top & Bottom Felt
22. Sash Stop
23. Nylon Wear Plate
24. Nylon Wear Shoe
25. Sliding Glass Unit
26. Stationary Glass Unit
27. Glass Unit
28. Sash Lock Keeper
29. Driver's Sliding Sash Lock
30. Driver's Window Rubber Seal

BAGGAGE DOORS

Baggage compartment doors are pantograph, vertical-lift type and are fully sealed. Each door has a flush-mounted latch handle. Doors are counterbalanced with springs for ease of operation and have a safety hold-open catch (figure 3-15). To open, insert fingers under latch, then pull outward and up. To close, hold latch in open position, pull downward on door and push down on latch to secure door. Rubber bumpers prevent the door from contacting the body when opened. Each door latch has provisions for a padlock and customs seal.

REMOVAL

WARNING: Because of their size and weight, removal of baggage doors should be performed by two persons.

1. Open door to half position. Remove the baggage compartment light and switch.

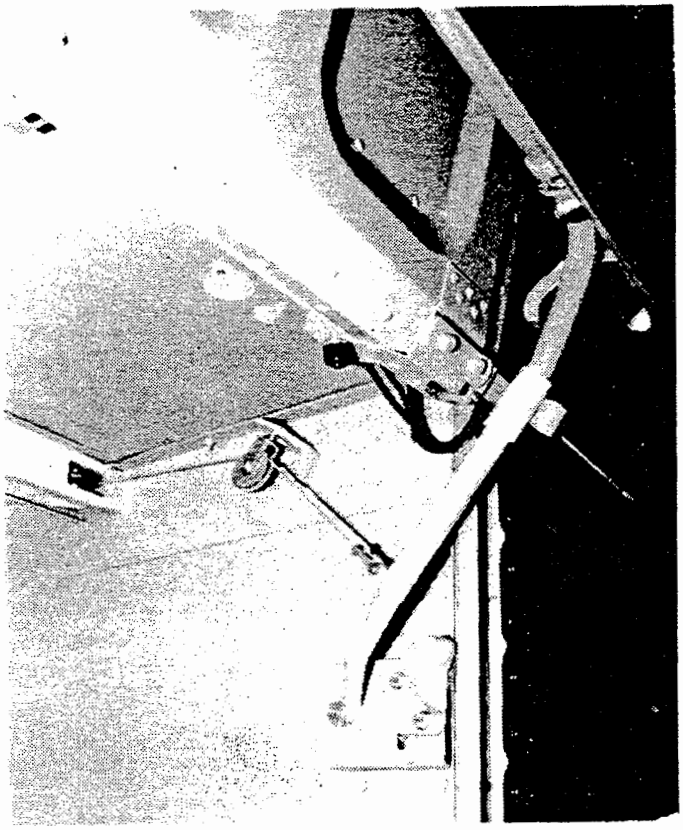


Figure 3-15. Baggage Door Hinge and Cable.

2. Remove the screws that secure the hinge panel to the coach body. Ensure that the door remains vertical. Open the door to its full position until the hinges engage with the hinge retaining clips.

WARNING: Baggage door must be supported at this stage to prevent it from falling during final removal procedures.

3. Using the baggage door cable pulling tool (20-46), pull cable back to facilitate the removal of the clevis pins that retain the pulley cables to hinge tubes.

4. Remove the capscrews that secure hinge tubes to the bracket and carefully remove the door from the coach.

WARNING: The pulley cable is under considerable tension. Exercise extreme caution during removal and installation.

INSPECTION

1. Inspect the pulley cables for fraying. Replace the cables if necessary.

2. Check the pulleys for wear and cracks. Replace them if either of these conditions exist.

INSTALLATION

1. Position and support the baggage door in the fully open position. Install the capscrews that secure the hinge tubes to the brackets.

2. Using the baggage door cable pulling tool (20-46), pull cable into position and insert the clevis pin into the yoke at the end of cable. Secure with new cotter pin.

3. Partially close baggage door and install screws securing hinge panel to coach body.

4. Install baggage compartment light and switch. Before closing door, ensure that pulley cables are aligned on pulleys.

ADJUSTMENT

1. If baggage doors lock too tightly and pinch seals at either top or bottom, or lock too loosely, it may be corrected by adjusting upper or lower catches on the inside edges of the baggage

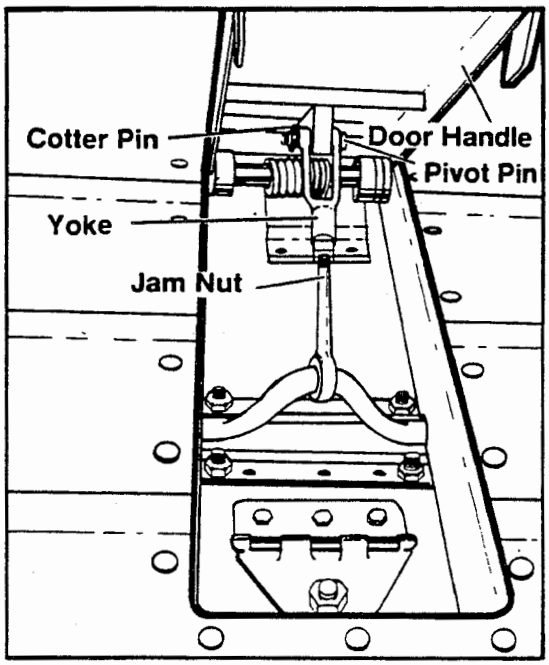


Figure 3-16. Baggage Door Catch.

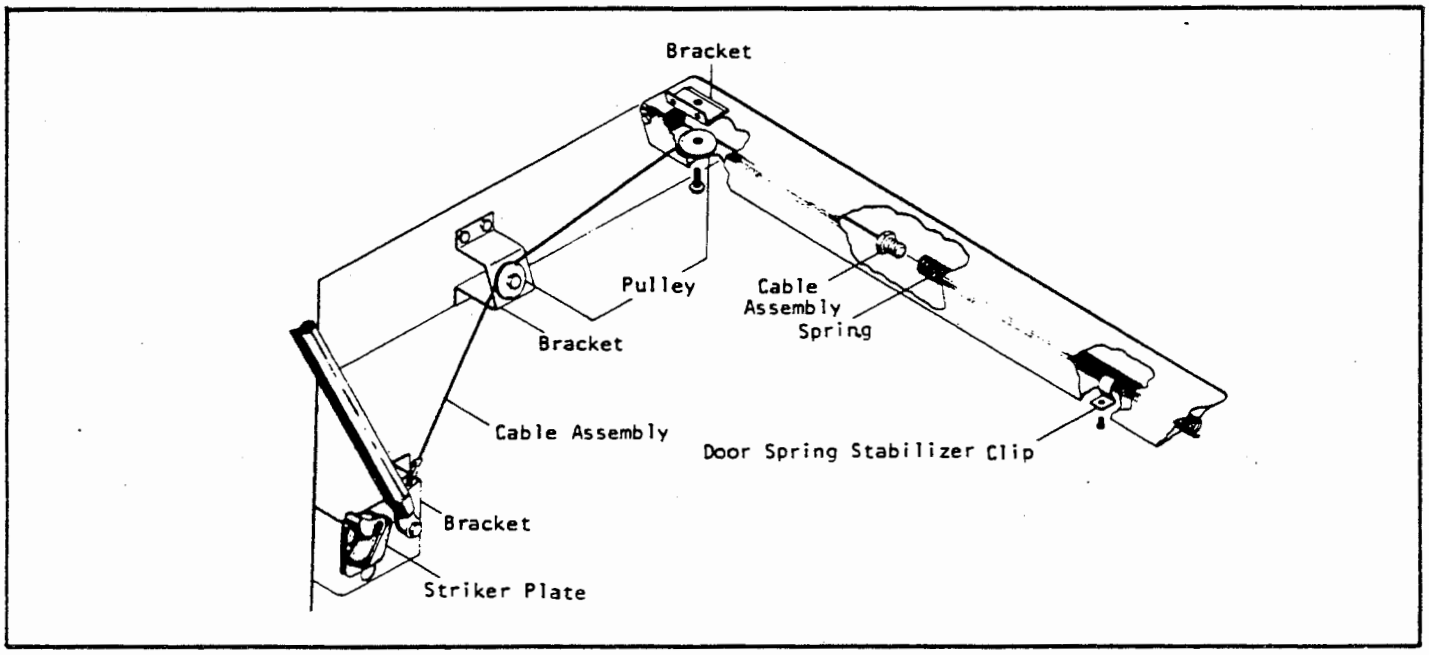


Figure 3-17. Baggage Door Opening Mechanism.

compartment. Loosen retaining capscrews and slide upper or lower catches to desired position and retighten.

2. Baggage door locks may be adjusted to provide an over-center lock. Remove cotter pin (on inside of operating latch —figure 3-16), retaining yoke pivot pin. Slide out yoke pivot pin. Loosen jam nut and turn threaded yoke to desired length.

3. Tighten jam nut and reverse procedure to reassemble.

DOOR SPRING REMOVAL

1. Fully open baggage door and support it to prevent it from falling when cables are removed.

2. Remove the two clips under the seat mounting rail.

3. Using the cable pulling tool (20-46) and the method outlined previously under removal, remove the two clevis pins that secure the pulley cables to the hinge tubes.

4. Remove the pulley and bracket assemblies at the seat mounting rail.

5. Pull cable and spring assembly out of seat mounting rail.

NOTE: In order to facilitate installation of a new spring, attach a stiff wire to one of the cables and pull the spring out of the rail at the opposite end. When the new spring is attached to the cable, pull the wire completely through the seat mounting rail. This will draw the spring into position inside the rail.

REASSEMBLY

1. Once the spring is in position inside the seat mounting rail, install the bracket and pulley assemblies.

2. Using the cable pulling tool and the procedure outlined previously, install the cables onto the hinge tube with the clevis pins.

3. Install the clips under the seat mounting rail. Before operating door, ensure that cables are aligned on pulleys.

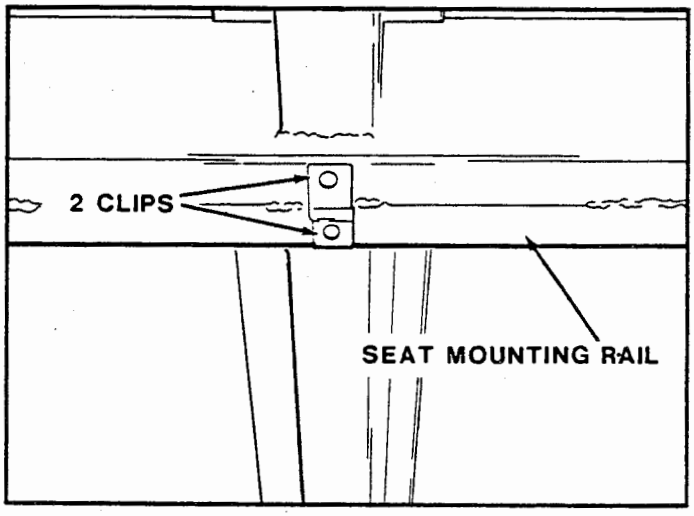


Figure 3-18. Clips Installed on Seat Mounting Rail.

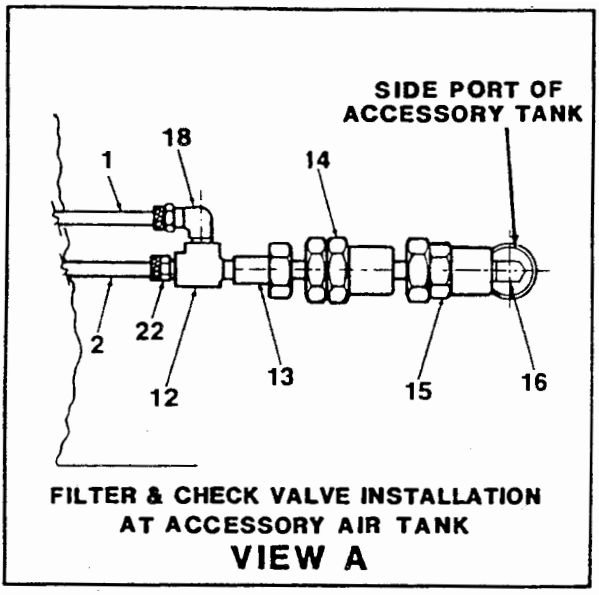
AIR OPERATED BAGGAGE DOOR LOCKING SYSTEM

An optional air operated baggage door locking system locks all six (6) baggage doors automatically with release of the parking brake.

To disengage the baggage door locking system, the parking brake must be applied, then a control button, located on the right hand portion of the dash directly below the entrance door air lock overrule valve, must be depressed. When the coach air system drops to approximately 60 PSI, the air operated baggage doors will lock and can only be released when the coach air pressure is returned to normal.

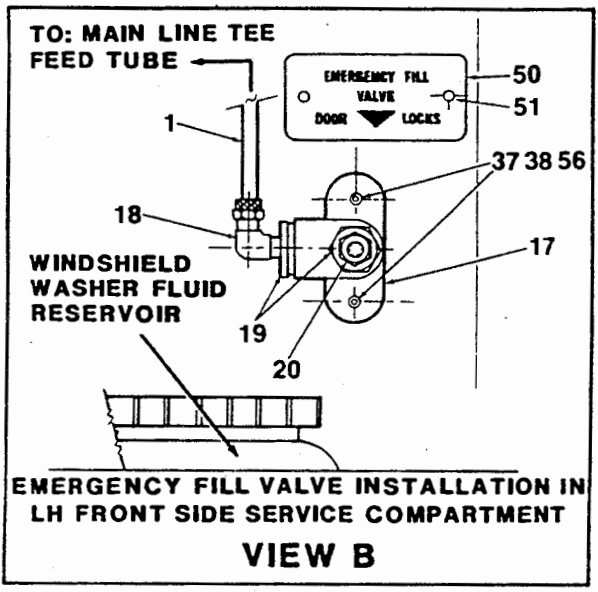
Separate restrictors are installed in air lines on each side in case of air line leakage on other side. In the event of total air loss to both air lines, an emergency air fill provision is located in L.H. front service compartment to permit operation of air cylinder to open baggage doors. Refer to figure 3-19.

1. Tubing-Accessory Air Tank to Emergency Fill Valve
2. Tubing-Accessory Air Tank to Door Valve Supply
3. Tubing-Door Valve Delivery Port to Door Cylinder Tee
4. Tubing-Door Valve Exhaust Port to Park Brake Valve
5. Tubing-Door Cylinder Tee to L.H. Interior Tee
6. Tubing-Door Cylinder Tee to R.H. Interior Tee
7. Tubing-R.H. Center Door Cylinder to Interior Tee; also L.H. Front Door Cylinder to Interior Tee
8. Tubing-L.H. Rear Door Cylinder to Interior Tee
9. Tubing-Interior Tee to Interior Tee (2 Places)
10. Tubing-L.H. Center Door Cylinder to Interior Tee; also R.H. Front Door Cylinder to Interior Tee
11. Tubing-R.H. Rear Door Cylinder to Interior Tee
12. Street Tee-1/8"NPT Brass
13. Reducer Coupling-1/4"Pipe X 1/8"Pipe Brass
14. Check Valve
15. Air Filter
16. Elbow-1/4" NPT Steel
17. Drop Elbow
18. Elbow-1/4"Tube X 1/8"NPT Brass
19. Reducer Bushing-1/4"NPT X 1/8"NPT Female
20. Valve
21. Plug-1/8"NPT Brass
22. Male Connector-1/4"Tube X 1/8" NPT Brass
23. Valve
24. Button
25. Restrictor Jet-.046 Orifice
26. Tee-1/4"NPT Brass
27. Street Tee-1/4" NPT Brass
28. Air Cylinder
29. Union Tee-1/4" Tube Brass
30. Plunger
31. Lockwasher-5/8"
32. Clamp-3/8"
33. Clamp-1/4"
34. Air Cylinder Mounting Bracket
35. Capscrew-1/4-20 UNC X 3/4"
36. Nut-1/4-20 UNC
37. Lockwasher-1/4"
38. Tapping Screw-#8-32 UNC X 1/2"
39. Machine Screw-#8-32 X 3/4"
40. Machine Screw-#8-32X1/2"
41. Hex Nut-#8-32 UNC
42. Lockwasher-#8
43. Reinforcing Hat Channel
44. Backing Washer
45. Nameplate-"Baggage Door Lock-Push to Open"
46. Nameplate-"Emergency Fill Valve-Door Locks"
47. Rivet-1/8"
48. Grommet-1/4' I.D. X 3/32" Groove
49. Tyrap
50. Loom-5/16" I.D.
51. Rivet-3/16" Stainless Steel
52. Lockwasher-1/4"
53. Flatwasher-1/4"



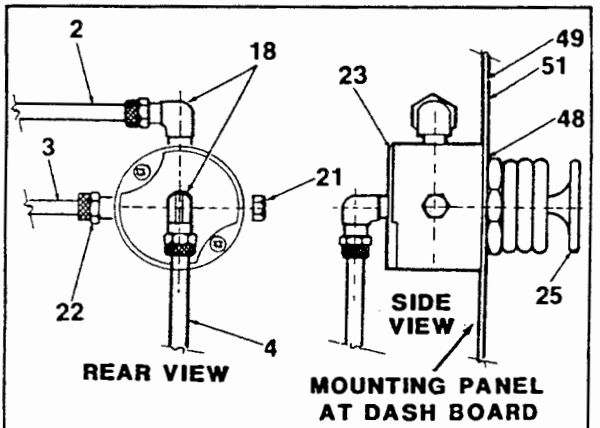
FILTER & CHECK VALVE INSTALLATION AT ACCESSORY AIR TANK

VIEW A



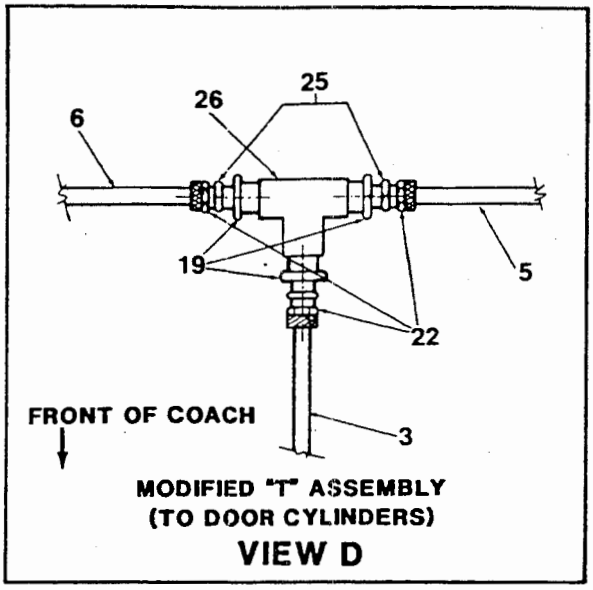
EMERGENCY FILL VALVE INSTALLATION IN LH FRONT SIDE SERVICE COMPARTMENT

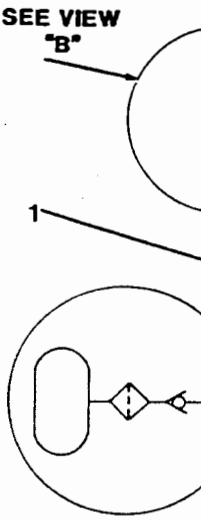
VIEW B

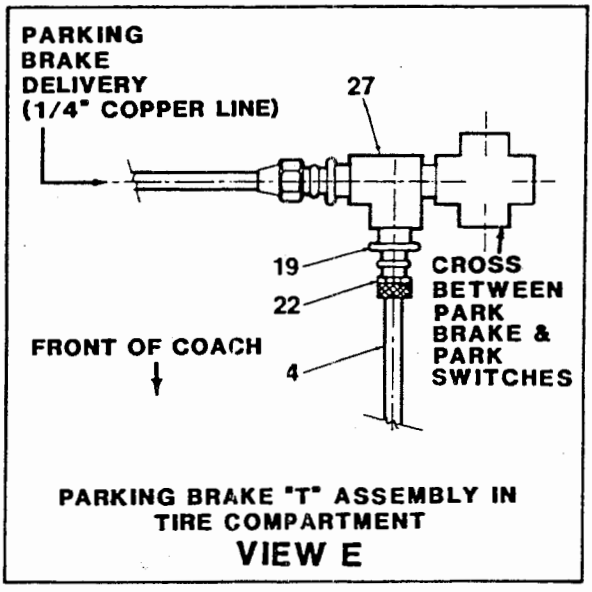


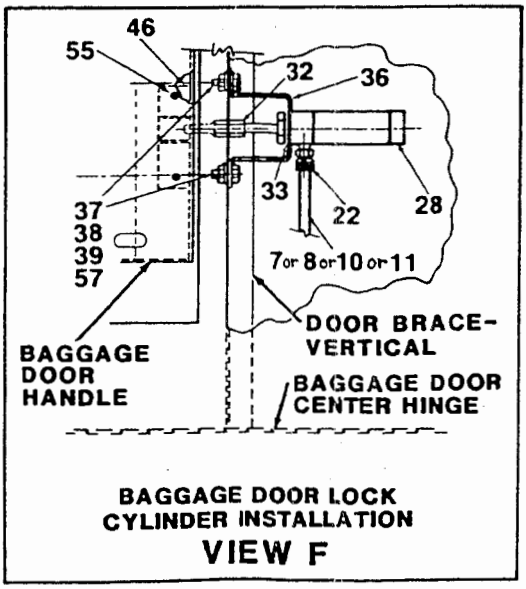
CONTROL VALVE INSTALLATION AT DASH

VIEW C









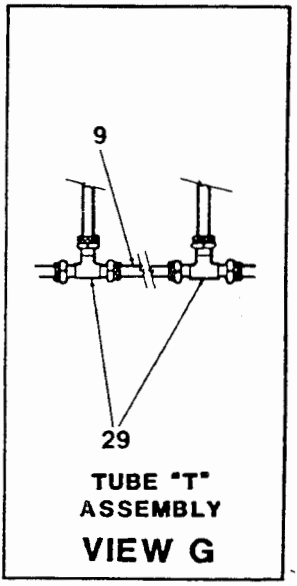
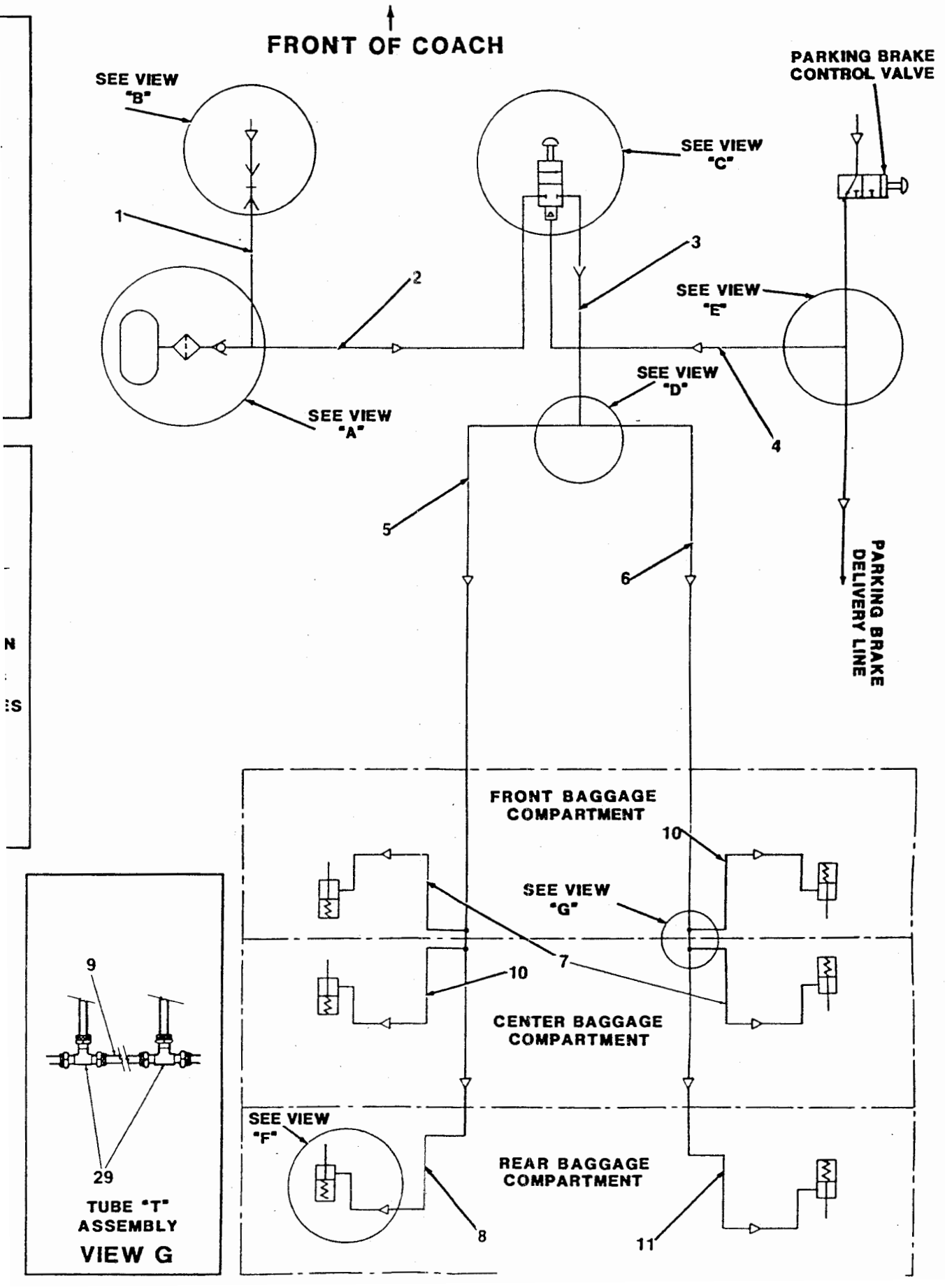


Figure 3-19. Air Operated Baggage Door Locking System.


FRONT OF COACH
SEE VIEW "B"
SEE VIEW "C"
PARKING BRAKE CONTROL VALVE
1
2
3
SEE VIEW "E"
SEE VIEW "D"
SEE VIEW "A"
4
5
6
PARKING BRAKE DELIVERY LINE
FRONT BAGGAGE COMPARTMENT
10
SEE VIEW "G"
7
10
CENTER BAGGAGE COMPARTMENT
SEE VIEW "F"
REAR BAGGAGE COMPARTMENT
8
11
9
29
TUBE "T" ASSEMBLY
VIEW G

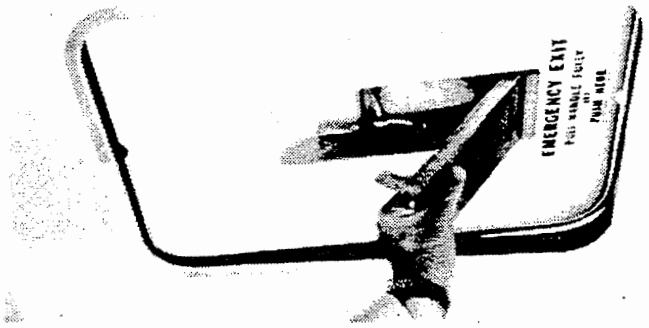


Figure 3-20. Emergency Escape Hatch.

EMERGENCY ESCAPE HATCHES

Two emergency escape hatches are located in the roof, opening size approximately 18" x 25" (457 x 635 mm). To open in case of emergency, pull handle fully to unlock and push hatch open. See figure 3-20. To close, pull hatch down with handle in open position, then push handle to lock hatch.

For ventilation, the hatch may be partially opened as above, then held by engaging the spring and prop mechanism. From this position, upward pressure on the hatch will release spring engagement and allow hatch to be fully opened. If hatch is to be closed from a partially open position, the prop must be disengaged by either opening the hatch until prop is freed or by pivoting the prop arm out of the open end of spring.

ADJUSTMENT

The emergency escape hatch in the roof can be checked and adjusted for correct hatch sealing as follows:

1. Open the emergency hatch and examine the surface of the rubber seal surrounding the hatch opening. An impression should be seen in the rubber where the sealing lip of the hatch has made contact. If the impression shows as a continuous unbroken line, the sealing is good and requires no adjustment.
2. If the line runs off the rubber across the forward edge, the hatch must be adjusted back toward the rear of the coach. This can be done by loosening the catch retaining bolts on both sides of the hatch opening and moving the catches back the required amount.
3. Close and then open the hatch to check the seal to determine if the hatch is centered; readjust if necessary. To obtain a clear impression of where the lip of the hatch contacts the rubber seal, it may help to chalk the edge of the lip.

NOTE: If additional forward or rearward adjustment is required, it may be necessary to remove the catches and elongate the slotted holes. If the line runs off the rear edge of the rubber seal when checking as above, the hatch must be adjusted forward.

ENTRANCE DOOR

DESCRIPTION

A manually operated, sedan type entrance door is provided ahead of the front axle on the right side of the coach. A handle on top of the dash convenient to the driver provides over-center control for both open and closed positions. Positive automatic air lock with overrule is also provided. The air lock is automatically actuated by a microswitch at the over-center position when door is closed. A plunger release with provision for padlock is provided at the front of coach.

The door is constructed of a welded stainless steel frame with a stainless steel beaded panel riveted on the outside. A vinyl-clad aluminum panel is used on the inside of the door with a stainless steel kick panel on lower portion. Stainless steel snap-on moldings cover all panel joints and the perimeter. A sturdy hinge casting is used at top and a powder-coated hinge casting with chrome self-aligning ball bearing is used at the bottom of the door. The sash is a one-piece, fixed type in a black anodized aluminum extruded frame with double glazing. Clear door opening is 30" (760 mm) wide x 84⅝" (2,150 mm) high.

The door is held in the closed position during coach operation by an air cylinder-operated locking mechanism. A single-acting air cylinder is used, having a return spring in the cylinder body. The air cylinder is controlled by an electrically operated valve which is energized by a microswitch located in the manual door control mechanism.

With the entrance door in the closed position, the microswitch is closed, energizing the air valve and loading the door lock cylinder. The cylinder moves the door lock in a position which engages a latch on the entrance door, holding the door positively closed.

To open the door, initial movement of the door operating handle opens the microswitch, de-energizing the air valve and venting the cylinder. The action of the return spring in the cylinder moves the door lock away from the latch. Further movement of the door control handle opens the door. Additional leverage is provided by an optional door control handle which is 1¼" longer than the standard handle.

An adjustment is provided at the microswitch in the event that this unit requires replacement. The microswitch is located under the dash directly beneath the door control handle. The correct adjustment is obtained when the microswitch contacts close as the door control mechanism begins to pass center during closing of the door.

An overrule switch, which opens the air valve circuit regardless of the position of the microswitch, is provided under the dash at the operator's position. This is designed for use in emergencies or when the door control system does not function properly.

ADJUSTMENTS

Provisions are made for the height adjustment of the entrance door by means of a threaded shaft on the upper hinge

arm. Locate the adjusting nuts behind the upper hinge cover. Loosen the upper jam nut. Rotate the lower nut either up or down, depending on the desired door movement. Once the adjustment is completed, tighten the top jam nut.

If the entrance door bottoms out, a second adjustment may be made at the lower hinge arm. Two screws are located at the slotted holes on the lower hinge arm. To lower the door further, loosen the screws, lower the door the necessary amount, and tighten the screws.

CONTROL ROD — The entrance door control rod may be adjusted with a lock type turnbuckle. Turnbuckle is accessible by an access door at the top right hand side of dash. Tighten nuts after desired adjustment is obtained.

If further adjustments are necessary, remove target panel at front below windshields, the jam nut at uniball end can be loosened and adjustments can be made by turning uniball end in or out as required. To retighten jam nut, it may be necessary to use a vise grip or a pipe wrench to hold control rod from turning.

CAUTION: Control rod bend at uniball end must point toward rear of coach when adjustment is completed.

CONTROL HANDLE — The oopen-lock and closed-lock positions can be adjusted. Viewing linkage from underside of dash, proceed as follows:

1. Loosen jam nuts on stop screws protruding from the control handle lever.
2. Turn stop screws in or out to desired setting.
3. Tighten jam nut and check adjustment by moving control handle from open lock to closed-lock positions.

Properly adjusted mechanism will swing over center and lock door firmly in both fully-open or closed positions.

MICROSWITCH — This can be adjusted if it does not energize or de-energize at correct times. The mounting bracket of the switch has slotted holes allowing it to be moved backward or forward. By loosening the mounting bolts, the bracket and switch can be set to a position where it will energize at correct position of lever and entrance door.

CAUTION: Switch must energize when entrance door is fully closed. If switch is set too far forward, it would energize and actuate the solenoid valve, which in turn controls the air cylinder, before the door is fully closed. If switch is set too far back, it would not be actuated and the door would not lock.

DOOR CONTROL SOLENOID

The door control solenoid located in the spare tire compartment controls the air supply to the door lock cylinder.

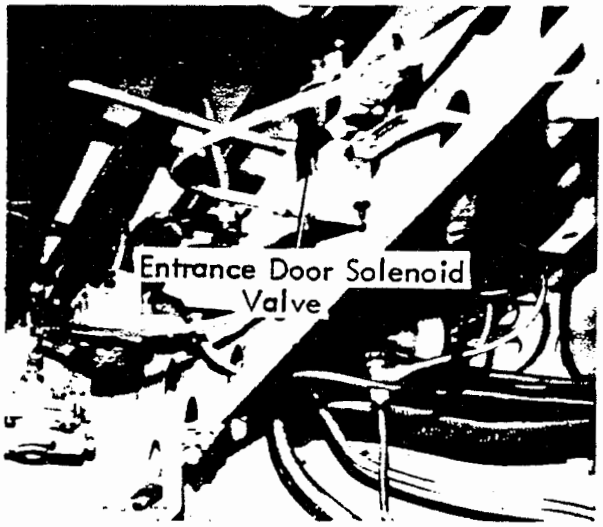


Figure 3-21. Entrance Door Solenoid Valve Installed.

DISASSEMBLY

1. Refer to figure 3-21. Shut off pressure to the valve and disconnect wiring harness.
2. Remove nut at top of coil cover. Cap, coil housing and coil can then be removed from body.
3. Unscrew the sleeve assembly from the body (figure 3-22).

CAUTION: Do not use a pipe wrench, as a wrench may crush the sleeve assembly and make the valve inoperative.

REPAIR

1. If the solenoid has failed to operate, the coil should be checked to make sure it is not shorted or open.

2. Occasionally valves may leak at the flange seal. Such a leak may damage the coil. A flange leak may be corrected by tightening the sleeve assembly into the valve body and/or replacing the seal.

3. If the valve leaks at the seat, or the plunger sticks in the energized position, examine the soft inserts in the plunger and the inside of the sleeve assembly for the presence of excessive dirt or wear. If the inserts show considerable wear, the plunger should be replaced.

4. If the solenoid develops a loud buzzing noise, examine the inside of the sleeve assembly and upper portion of the plunger. Remove all foreign matter imbedded in these parts.

5. If the valve leaks internally, examine the piston insert for excessive wear. Also inspect main exhaust orifice for dirt accumulation, scratches and nicks. Replace parts as necessary.

6. If the valve is sluggish during operation, check for dirt accumulation or wear on both piston and piston bore. The piston should slide freely into the piston bore without binding. Inspect and clean all passageways of dirt.

MC-9 MAINTENANCE MANUAL

REASSEMBLY

1. Reassemble the valve by following the disassembly procedure in reverse order. Make sure the seal at the flange end of the assembly and the return spring are in place when the sleeve is screwed into the body.

2. After screwing the flange into the body and before assembling the coil to the valve, it is advisable to apply air pressure to the part which leads to the body chamber and check for leakage around the flange. If the valve has a sleeve port, this port at the top of the valve must be capped to make this test. If the medium is air or gas, leakage can be noted by applying water to the joint and watching for air bubbles. If the medium is liquid, leakage is readily apparent.

CAUTION: Do not excessively tighten the nut at the top of the coil housing, since doing so will put undue strain on the sleeve assembly.

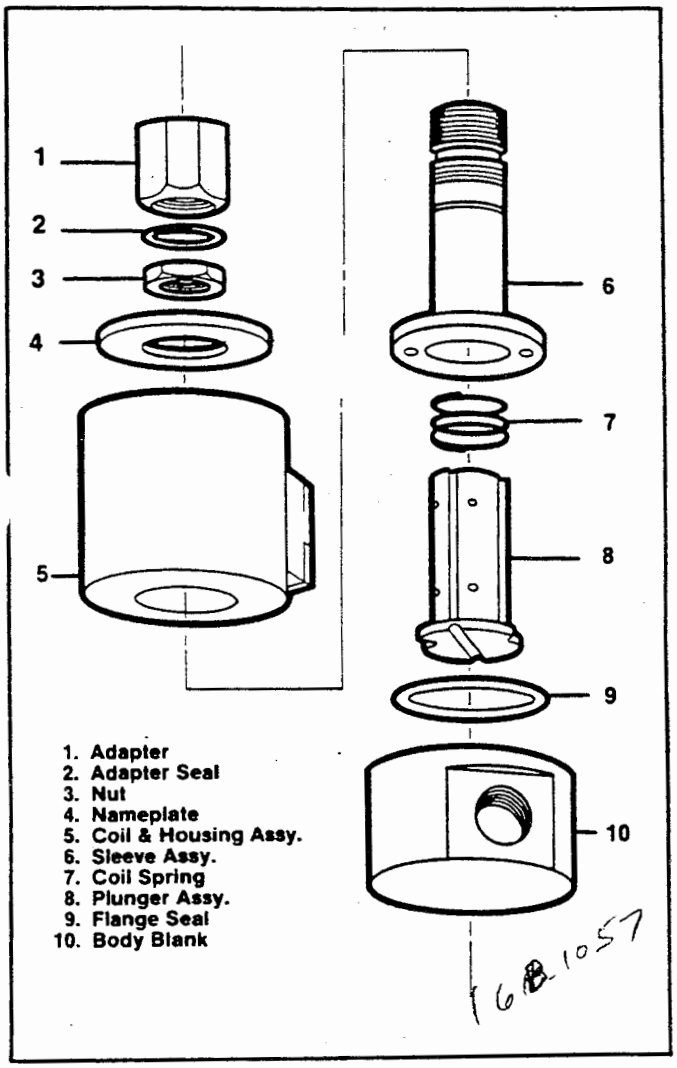


Figure 3-22. Entrance Door Solenoid.

ENTRANCE DOOR AIR CYLINDER

DESCRIPTION

The entrance door air cylinder is a single-acting type which holds the door in the closed and locked position during coach operation.

MAINTENANCE

It is recommended that the entrance door air cylinder be lubricated at regular intervals, approximately every 30,000 miles (48,000 km). The recommended procedure is as follows: Remove air feed hose and put in a few drops of SAE-30 engine oil into the cylinder through air hose connector. Reconnect the feed hose, reverse the air supply to the cylinder; this will lubricate the other end of the cylinder. Check air cylinder for leaks. It should also be noted that when overhauling air cylinder, it is important to replace all seals, felts, cups and O-rings with new parts for proper operation. Also, when overhauling air cylindker the new parts should be coated with SAE-30 oil before assembly.

ADJUSTMENT

The entrance door air cylinder can be adjusted to provide close fitting of door. If door vibrates or is not locked firmly in position, make adjustments in the following manner.

1. Remove panel on rear wall of stepwell to gain access to air cylinder.
2. Remove cotter pin and yoke pivot pin to free yoke at anchor end of air cylinder.
3. Loosen jam nut and turn yoke to lengthen or shorten stroke of piston rod as necessary.
4. Tighten jam nut and reassemble.

Further adjustments can be made to provide a closer fit between latch nose and latch pad. Slotted holes are provided in the latch nose mounting for this purpose. To adjust, loosen the mounting bolts and set latch nose at the desired position. Retighten bolts.

MC-9 MAINTENANCE MANUAL

BI-PARTING ENTRANCE DOOR

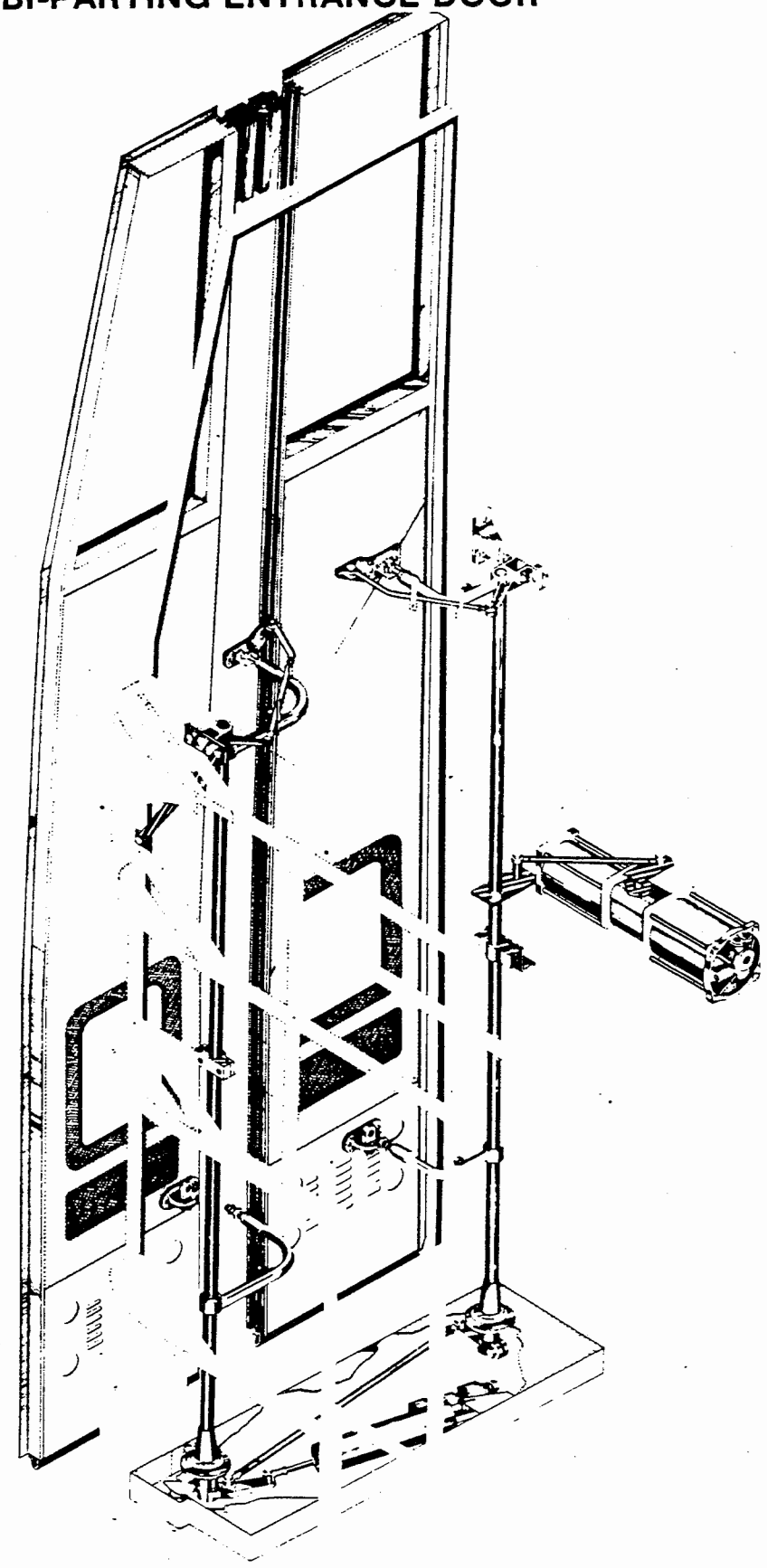


Figure 3-23. Bi-Parting Door And Linkage.

MC-9 MAINTENANCE MANUAL

MCI BI-PARTING ENTRANCE DOOR (OPTION) AND CONTROL MECHANISM

DESCRIPTION

The Bi-Parting Entrance door is an air power operated, two-piece, outward opening type door. Clear opening of the entrance door is 24 inches by 83 inches (609.6 by 2108 mm). Meeting edges of the door panels are provided with flexible rubber cushions, 2 inches (51 mm) wide for passenger protection. Door panels are double glazed at the top with single-density tempered safety glass. Lower windows are single glazed with Lucite panels. The front panel has an exhaust outlet near the bottom on the interior side.

The door panels and operating shafts are mechanically linked to a master air-operated cylinder. The master air-operating cylinder is a geared-differential, air-operated device consisting of two horizontally opposed cylinders of different diameters. A rack gear connects the pistons which operate within the cylinders. The rack meshes with a gear which converts the straight line motion of the pistons into rotary motion necessary for operation of the linkage and door shafts assemblies.

The master cylinder is designed to operate at 60 to 120 PSI (414-828 kPa) air pressure. During normal operation, air pressure is continually applied to both cylinders — directly to the smaller "opening" cylinder from the reservoir, and from the normally open solenoid valve to the larger or "closing" cylinder. Door operating pictorial and air system schematic diagrams are found at the end of this writeup.

In the door-opening process, air pressure to the large cylinder is shut off and permitted to bleed off at a controlled rate through adjusting ports back through the exhaust port in the solenoid valve. At a predetermined point in the opening cycle, horizontal movement of the rack-and-piston assembly closes off the primary air exhaust port by action of the seal cushion. The greater pressure in the smaller cylinder causes the movement of the piston in the large cylinder to compress the remaining air which is bleeding off more slowly through the cushioning speed port. This compressing action provides the means of controlling the opening action of the doors, thus preventing the door panels from slamming open. As the doors are fully opened, the remaining air pressure in the large cylinder is slowly depleted through the cushioning speed port and out through the solenoid valve exhaust port.

In the door-closing process, air pressure is admitted through the opening-speed port cavity which was sealed by the seal cushion. With the aid of the compression spring, the cavity is soon opened and the main area of the large cylinder begins to fill with air. Due to the larger piston area in the opening cylinder, the net force difference causes the rack to move in the closing direction, thus closing the doors.

The rear panel and shaft is the driving medium for the front panel and shaft. The front panel is controlled by the movement of the rear shaft through a linkage bar below the lower step. A push-pull slave cylinder is connected to the front panel shaft to provide the necessary force to tightly close the front panel. When the door opens the slave cylinder quickly exhausts and the master and slave cylinders pull both panels to the open position.

DRIVER'S SWITCH

This is a toggle switch with legend plate, located to left of driver's position, on top forward face of switch panel. This switch is provided for normal opening and closing of the door by the operator while within the coach.

EXTERIOR SWITCH

The door is opened or closed from the exterior of the coach by means of a momentary-type toggle switch. The switch must be held in the desired position until the door has completed its movement. A legend plate is attached just under the switch.

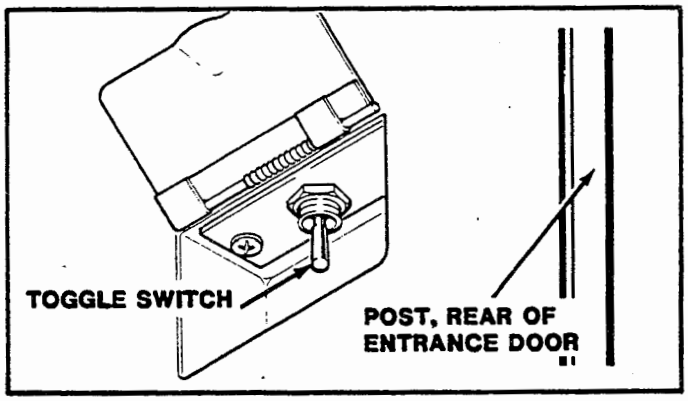


Figure 3-24. External Entrance Door Switch Control.

The switch is located in a pocket in the exterior body panel below the #1 RH passenger window and to the rear of the entrance door. The pocket has a spring-loaded cover which conceals and protects the switch (figure 3-24).

MANUAL AIR DUMP

If the electrical circuit to the solenoid valve fails while the operator is inside the vehicle, a hand operated air valve is provided, which allows exhausting of all air from the door operating cylinder (figure 3-25). With the air exhausted, the door panels can be manually pushed to the open position. The air dump valve is located to the right of driver's position and below the dash panel. This valve can be identified by a legend plate with instructions for use, and is further identified by a lever with a small red knob.

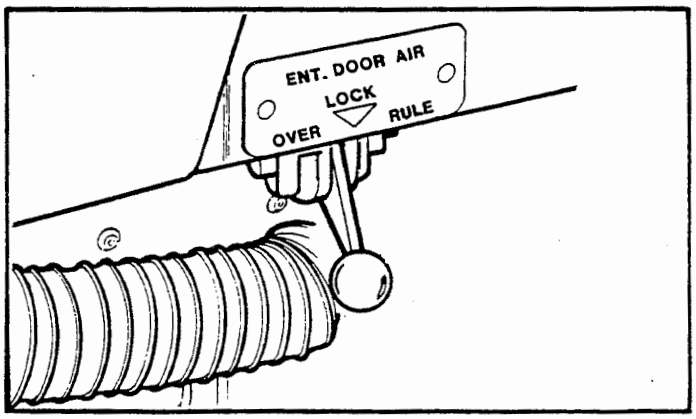


Figure 3-25. Air Dump Valve.

In the event that an electrical malfunction occurs while the operator is outside the vehicle, the above dump valve can also be controlled from outside the vehicle. A push-pull control cable is located in the left front electrical junction box (figure 3-26).

The control cable can be reached by opening the exterior junction box access door. By pulling the black knob to full out position, the air dump valve described above is actuated to the exhaust position. The door panels can then be manually pulled to the open position from outside the vehicle.

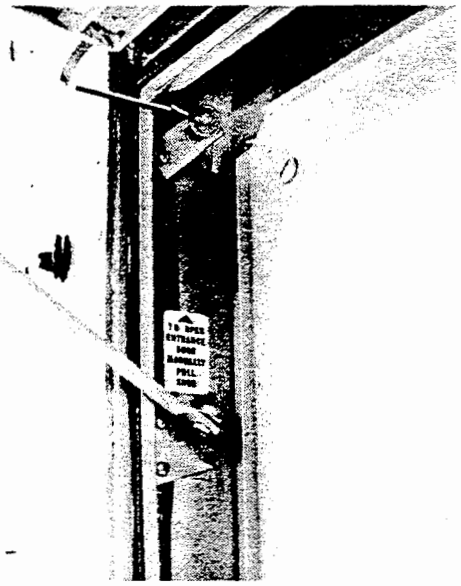


Figure 3-26. External Push-Pull Air Dump Valve Control.

STEPLIGHT - PRESSURE SWITCH

Automatic actuation of the steplight is provided by means of a pressure-type switch in the door control air system. The pressure switch is installed in the air line to the slave cylinder.

With the steplight and chime switch in the "on" position, and with door in open position, air pressure is exhausted out of the slave cylinder line. The loss of pressure energizes the switch and illuminates the steplight. Conversely, when the door is in closed position, air pressure is present in the slave cylinder line and the pressure switch "breaks" to put the steplight off.

In the open position, the steplight pressure switch can be overruled to turn the steplight off by selecting "off" position with the steplight and chime switch.

ADJUSTMENT PROCEDURES

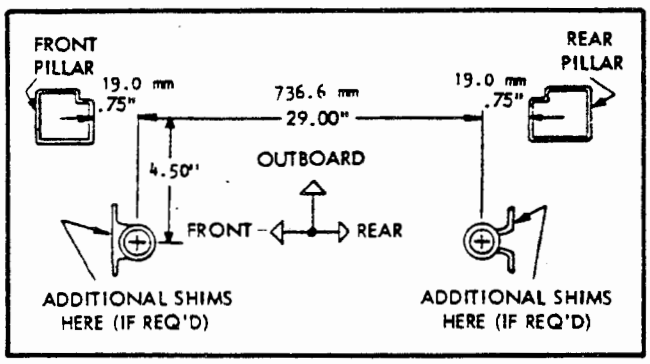


Figure 3-27. Adjustment of Upper Brackets.

1. Refer to figure 3-27. Check fore and aft dimension between shaft centers. Centers should measure 29.00 in. (736.6 mm). If centers are less than 29.00 in. (736.6 mm), remove shims between brackets and spacers.

NOTE: Always shim both brackets equally to keep shafts centered in door opening.

2. Conversely, if the center distance between brackets is greater than 29.00 in. (736.6 mm) in addition to the standard spacer, a shim pack of the correct thickness should be added. Insure that both brackets are shimmed equally.

INSTALLING REAR SHAFT ASSEMBLY

1. Place bottom of rear shaft assembly through bore of lower rear bearing assembly until upper pin of shaft can be inserted through bottom of spherical bearing in upper bracket.
2. Lift shaft until shoulder seats on bottom of spherical bearing.
3. Install self-locking nut on top of shaft.

INSTALLING FRONT SHAFT ASSEMBLY

Follow same procedure for installation for front shaft as for rear shaft, above.

INSTALLATION - SHAFT BEARING BLOCKS

1. Select a matched set of reamed bearing blocks. Position base block between shaft and mounting bracket. Shim between base block and bracket as required.

2. Position cap block over shaft and align mounting holes. Install capscrews with lockwashers and nuts on rear of brackets.

This procedure is the same for both the front and rear shafts.

INSTALLATION - BOTTOM LINKAGE

1. Tighten all lower bearing mounting nuts below bottom step.
2. Slide bearing locking collar up shaft into contact with bearing.
3. Rotate collar until tight.
4. Tighten set screw in locking collar.
5. Install woodruff keys in keyseats on shafts.
6. On rear shaft, align keyway in lever arm, with key in shaft and slide arm up shaft until approximately 1/16 inch (1.5 mm) of shaft protrudes through bottom of arm. Tighten capscrews in lever arm to lock arm on shaft.

7. For front shaft, follow same procedure using lever arm.

8. When installing linkage rod, insure that center-to-center of rod eyes is 28⅞ inches (733.4 mm). Install rod assembly between rear shaft lever arm and inner hole of front shaft lever arm. Install with capscrews and self-locking nuts on bottom end.

NOTE: Do not install capscrews from bottom up.

9. Install capscrew through rod eye of slave air cylinder and outer hole of front lever arm.

INSTALLING AIR-OPERATED CYLINDER LINKAGE

1. Measure linkage rod assembly to insure that center-to-center of rod eyes is 9¼ inches (235 mm). Install rod assembly with lubrication fittings facing stepwell.

2. Install flatwasher and capscrew in top of lever arm stud at cylinder.

3. Install self-locking nut on stud of shaft lever arm.

ADJUSTING SHAFT BUMPER STOPS

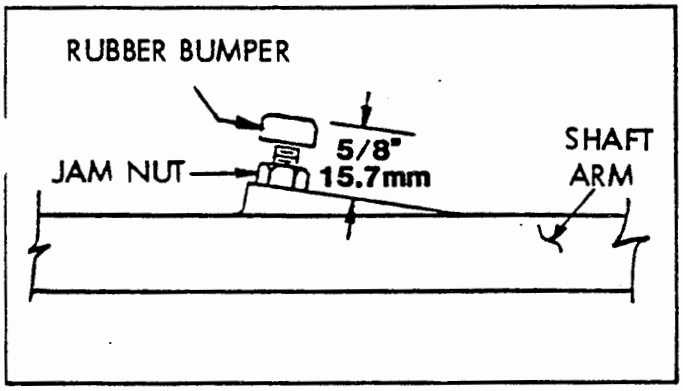


Figure 3-28. Adjustment - Shaft Bumper Stops.

1. Refer to figure 3-28. Adjust rubber bumper stops on both shafts to ⅝ inches (15.9 mm). Tighten jam nuts.

2. Manually move shafts and linkage through full travel. Check for smooth movement without any binding. Action should be stiff but not excessively hard to move manually.

SHAFT SOCKET ASSEMBLIES ADJUSTMENT

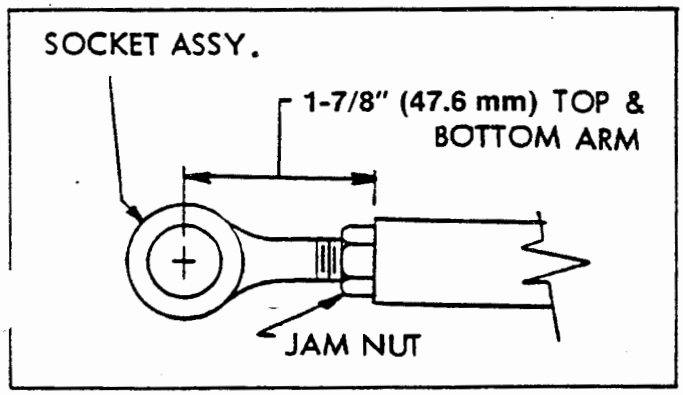


Figure 3-29. Adjustment - Shaft Socket Assemblies.

Adjust socket assemblies on shaft arm ends to dimensions shown in figure 3-29.

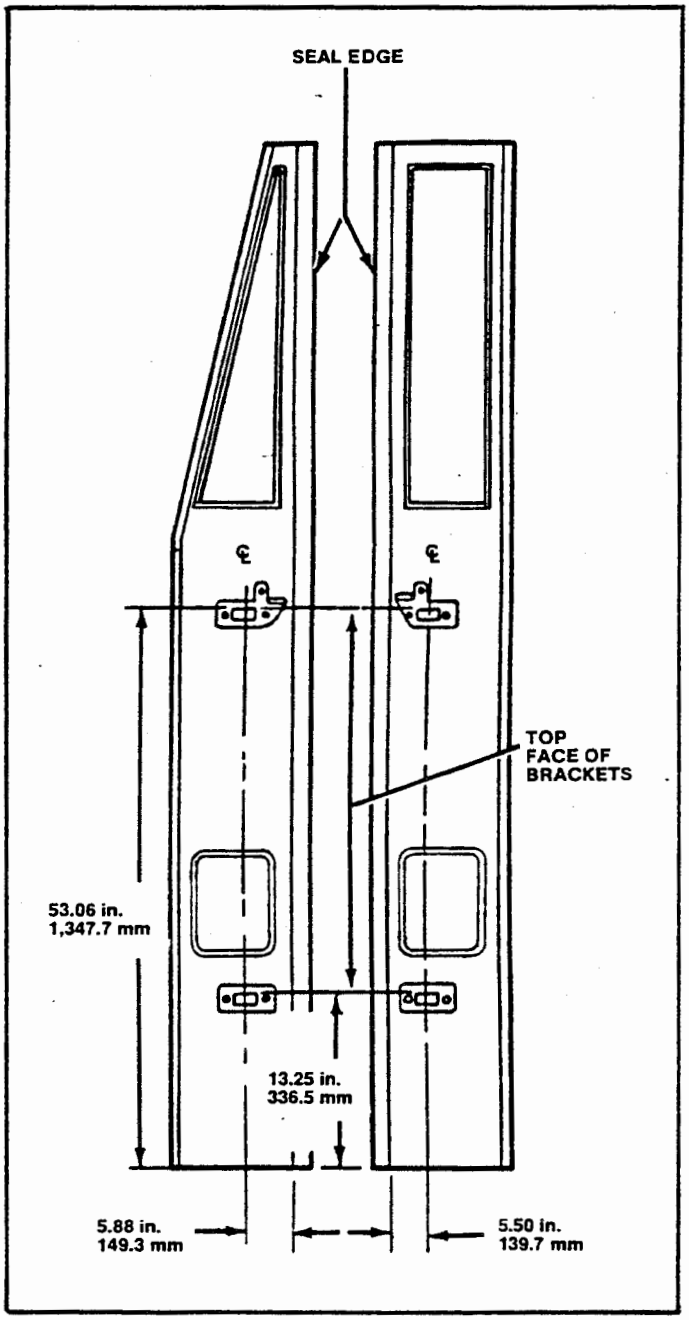


Figure 3-30. Installation - Door Panels.

INSTALLATION OF DOOR PANELS

1. Check position of upper and lower hanger brackets on each door section. Insure that brackets are positioned in accordance with dimensions shown in figure 3-30.

2. Position each door panel on shaft arms with tapered stud of socket assembly through hole in upper and lower door-mounting brackets.

3. Install castellated nuts on bottom end of tapered stud. Install cotter pins in stud ends.

INSTALLATION OF CONTROL ARMS

1. Measure rear door control arm to insure that center-to-center of rod eyes is 11 9/16 inches (293.7 mm) measured in a straight line, eye to eye.

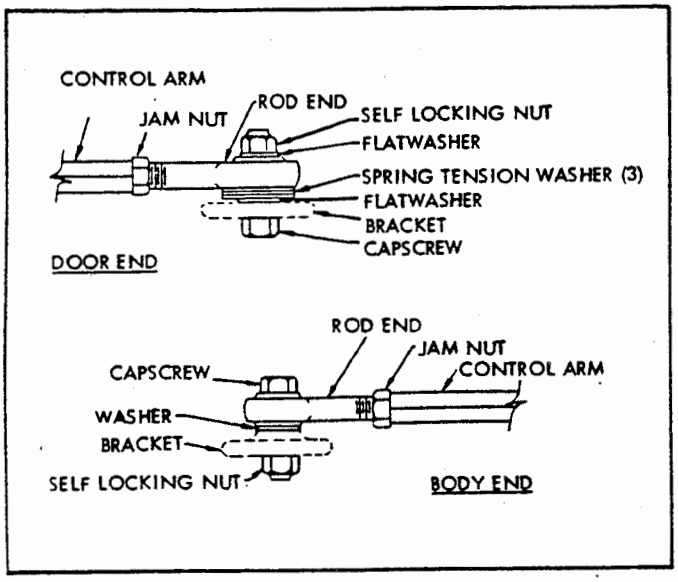


Figure 3-31. Installation-Control Arms.

2. Install rod assembly with bend to rear of coach. Both ends of rod are to be installed as shown in figure 3-31.

3. Measure front door control arm to insure that center-to-center of rod eyes is 12 1/16 inches (305.2 mm) measured in a straight line, eye to eye. Install rod assembly with bend to front of coach. Both ends of rod are to be installed as shown.

DOOR OPERATION CHECK

1. Move both door panels manually through full open and closed positions. Check for interference between front door panel and body panels, RH exterior rear view mirror, corner bumper, etc.

2. Move door panels to closed position. Check for door to body clearances.

3. Place battery switch in ON position. Place manual air valve at driver's position to air on position.

4. Check both the interior and exterior operator's door control switch to cycle door from both positions.

NOTE: To check door operation, coach air system should have a minimum of 85 PSI (586 kPa).

5. With air on and door closed, check for the following:

a. A proper seal takes place between both door panels.

b. Clearance between doors and body should be ¼ inch (6.35 mm) minimum from top to bottom. At top of doors, clearance should be ⅛ inch (3.17 mm). If these clearances are not correct, refer to Final Adjustments for corrective procedure.

c. Inner feather body seal fits snug to sides and top of doors.

d. Check contour of doors with contour of body. Door panels should follow contour of body from top to bottom, and be parallel with vertical door opening.

e. Control arms should be loose (no pressure) when door is closed.

6. With air on and door open, check for conformance to dimensions as shown in figure 3-32.

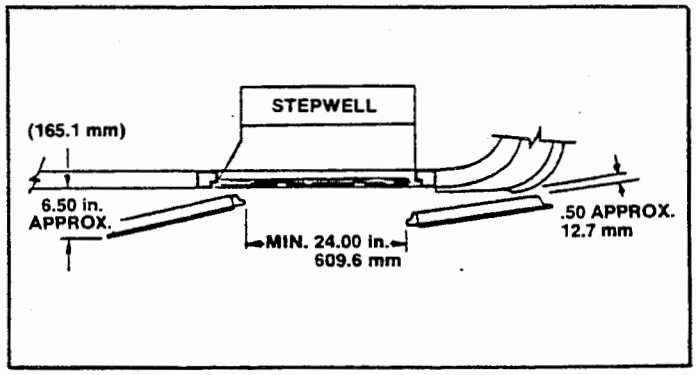


Figure 3-32. Door Open Dimensions.

FINAL ADJUSTMENTS

1. If further adjustments are required to door panels, refer to the following procedures:

Door panel too high or too low.

a. Loosen capscrews in both upper and lower hanger brackets.

b. Move door panel up or down as required.

c. Tighten capscrew in brackets.

Door panel on angle.

a. Loosen capscrews in top or bottom bracket.

b. Move door panel in direction required to correct clearance between door and body.

c. Tighter capscrew in brackets.

Rear panel angle incorrect.

a. Remove one end of rear control arm.

b. Loosen jam nut on rod end.

c. Turn rod end out to increase angle. Turn in to decrease angle.

d. Tighten jam nut.

Front panel angle incorrect.

Same procedure as for rear panel. Also, check for door to mirror arm clearance and minimum opening dimension.

Door control arms binding.

The center of the door control arms should be free to move up and down slightly with the doors fully closed. If any are tight, release air from the door system with the air dump valve next to the driver's area, disconnect one rod end on the end of the tight arm(s), close doors manually, and reapply air. Note that doors should be in the closed position during this adjustment. Adjust rod end until it can be easily reinstalled. Replace and tighten nut.

2. If further adjustments are required to the shafts and control linkages, refer to the following procedures:

Insufficient travel of rear shaft and arm.

a. Loosen jam nuts on master cylinder linkage rod.

b. Turn rod required number of turns to increase length of rod.

c. Tighten jam nuts.

Too much travel of rear shaft and arm.

a. Loosen jam nuts on master cylinder linkage rod.

b. Turn rod required number of turns to decrease length of rod.

c. Tighten jam nuts.

Insufficient travel of front shaft and arm.

a. Loosen jam nuts on bottom linkage rod below stepwell.

b. Turn rod required number of turns to decrease length of rod.

c. Tighten jam nuts.

Too much travel of front shaft and arm.

a. Loosen jam nuts on bottom linkage rod below stepwell.

b. Turn rod required number of turns to increase length of rod.

c. Tighten jam nuts.

Insufficient inward pressure of door to seals.

a. Remove door panel assembly from shaft arms.

b. Loosen jam nuts on socket assembly.

c. turn socket assembly in to increase pressure.

Too much inward pressure of door to seals.

a. Remove door panel assembly from shaft arms.

b. Loosen jam nuts on socket assembly.

c. Turn socket out to decrease pressure.

ADJUSTMENT OF MASTER AIR CYLINDER

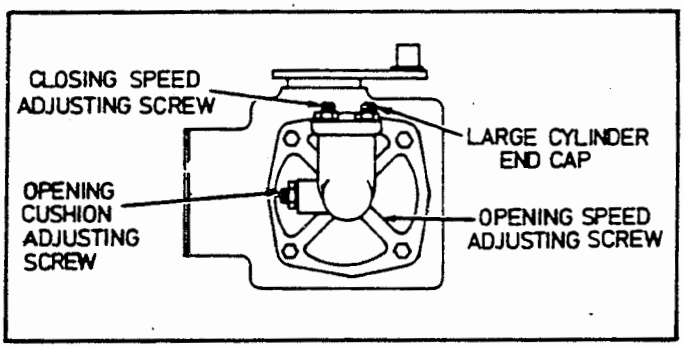


Figure 3-33. Master Air Cylinder Adjusting Screws.

The door master cylinder has factory pre-set adjustment for proper opening, closing and cushioning speeds. However, if adjustments are required, the following procedure should be followed. Refer to figure 3-33.

1. To increase the door-closing speed, loosen the locknut which secures the closing-speed adjusting screw and turn the screw outward. To decrease the closing speed, turn the screw inward. Be sure to tighten the locknut to maintain the adjustment.

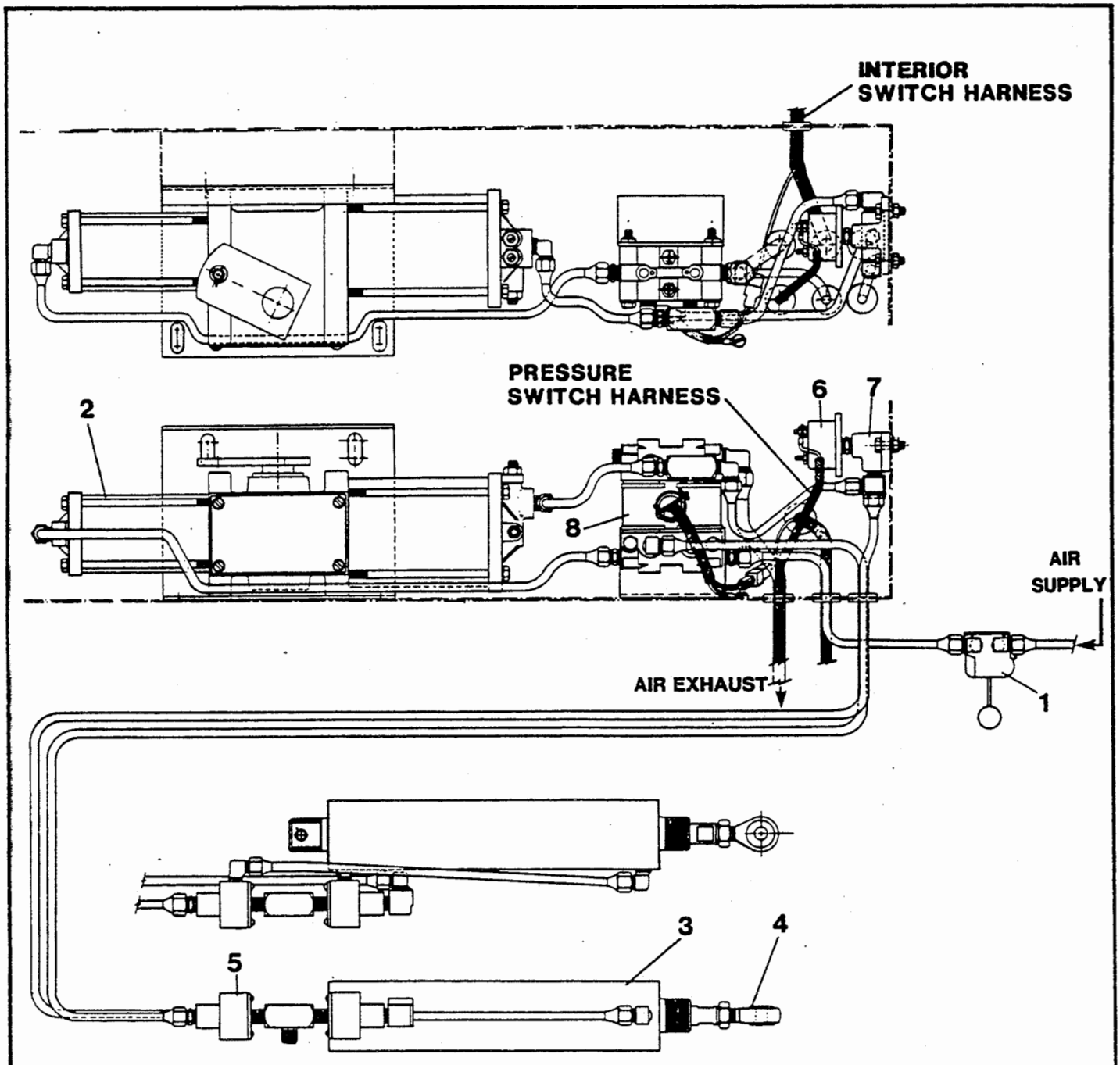
2. To increase the door-opening speed, loosen the locknut which secures the opening-speed adjusting screw and turn the screw outward. To decrease the speed, turn the screw inward. Tighten the locknut to maintain adjustment.

3. To adjust the cushioning during the opening cycle, loosen the locknut and carefully adjust the opening cushion screw. Be sure to tighten the locknut after making adjustment.

NOTE: When making adjustments, always adjust the closing speed first since this adjustment also affects the door-opening speed.

CAUTION: Never force adjusting screws when adjusting in a clockwise direction. Excessive tightening pressure will damage orifices in cylinder and cap.

MC-9 MAINTENANCE MANUAL



1. MANUAL AIR DUMP VALVE
2. MASTER CYLINDER
3. SLAVE CYLINDER
4. ROD END
5. QUICK RELEASE VALVE
6. PRESSURE SWITCH
7. ANCHOR ELBOW
8. SOLENOID VALVE

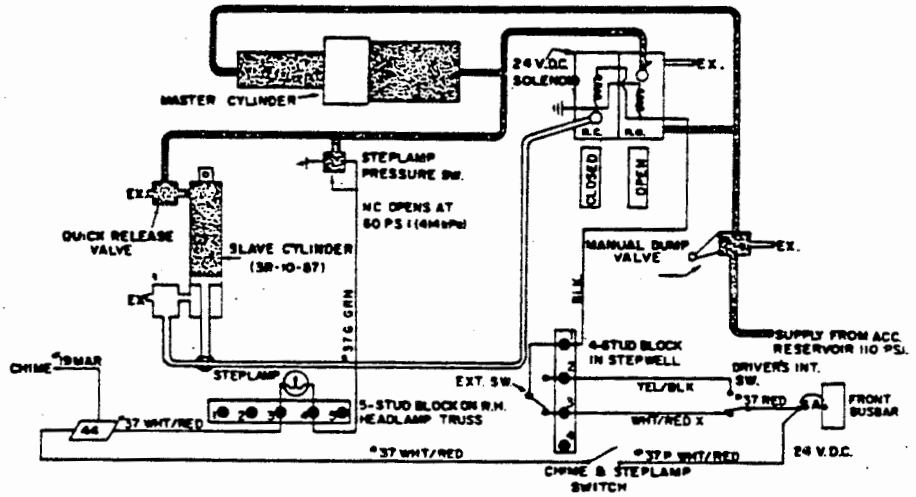
Figure 3-34. Bi-Part Door Master Air Cylinder Layout.

MC-9 MAINTENANCE MANUAL

BI-PARTING ENTRANCE DOOR

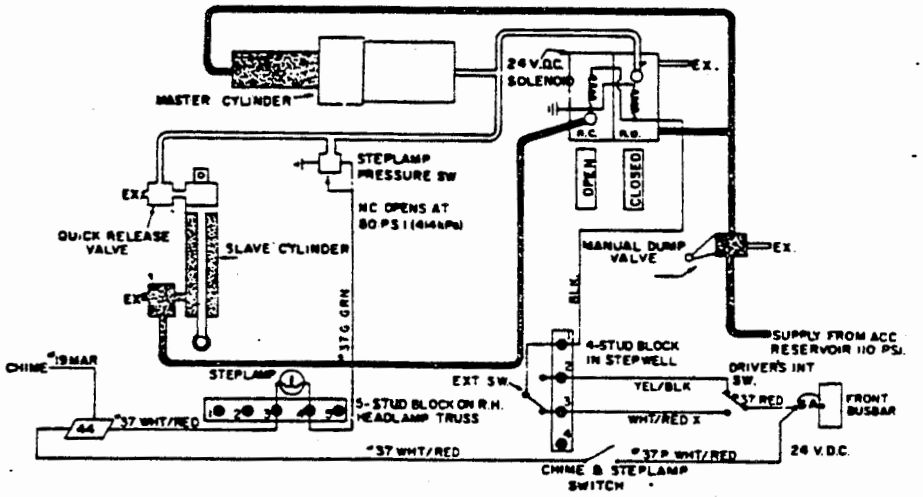
DOOR CLOSED

ON AIR PRESSURE OFF



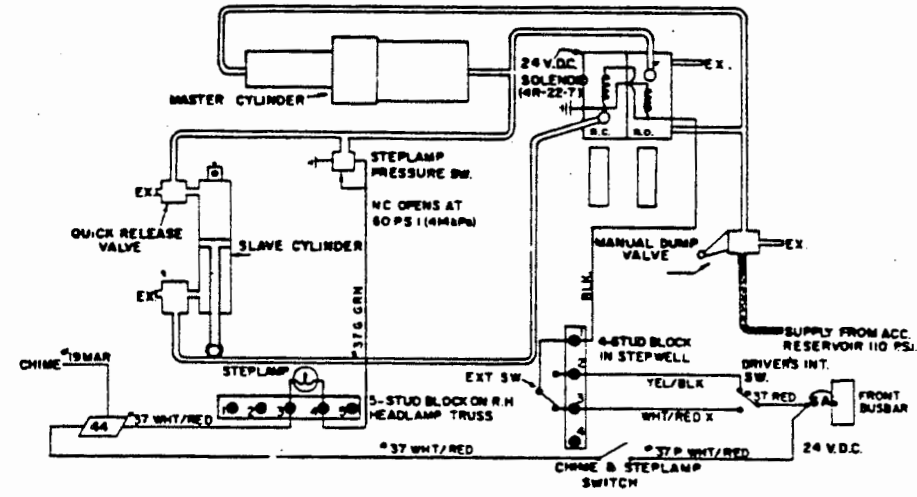
DOOR OPEN

ON AIR PRESSURE OFF



MANUAL AIR DUMP

ON AIR PRESSURE OFF



NOTE ABOVE WIRING IS ALL 16 GA

Figure 3-35. Bi-Parting Door Air System.

MC-9 MAINTENANCE MANUAL

WINDSHIELD WIPERS

Two heavy duty air operated "Air Push II" windshield wipers are installed, one for each windshield. Individual control valves with built-in air pressure regulators are provided on the front dash. Regulators provide constant speed as adjusted by the control valve. Air pressure variations do not affect wiper action. Wiper motors are removable from the exterior of the coach. Each motor incorporates a 2" (51 mm) diameter piston and a ⅝" (16 mm) diameter drive shaft. Wipers are "self parking" pantograph with 20" (508 mm) flexible wiper blades.

MAINTENANCE

Wiper motor, control valves require no periodic maintenance between overhaul. At overhaul, the windshield wiper motors and wipers should be disassembled, cleaned and lubricated with Sprague Wiper Lube. The following guidelines are to be used on new or rebuilt wiper motors to increase service life.

A. One of the best preventive actions is not to let the wiper system sit too long without operation. Wiper systems should run every other day, if only for a few cycles. This action will keep the lubricant and O-rings movable and less likely to "take a set." This is very important on older vehicles or systems which pass along a large amount of air line contamination. Contaminants tend to thin lubricant and wash it from the motor valve. It can be strong enough to attack O-rings, causing swelling and deterioration.

B. If the system has seen heavy usage or is an older unit, it is recommended that it be removed and updated with new O-rings and fresh lubricant. Additional lubricants can be used as a preventive maintenance or as a field fix for sticky units. If O-rings are not damaged and the motor is not frozen, lubricant injected in the air lines will keep a motor running. We recommend that ½ ounce be injected into each motor at a location as close to the motor valve as possible Allow motor to run 15 minutes (remove arm or place a rag under blade) to work through the valve.

Lubricating in this manner every six months is sufficient. Where heavy contamination is present, more frequent applications may be required. We recommend using Sprague Wiper Lube, part number Y-143. Do not use any type of penetrating fluid or oil. While these will free a motor, they will break down lubricants in the motor and attack O-rings. Only under emergency situations should these be used and should be followed by the addition of lubricating oil and, if possible, a breakdown and manual regreasing of the motor.

C. Every 100,000 miles (161,000 km), the air strainer should be disassembled and cleaned.

D. In-line oilers will act as an air filter as well as keep a supply of oil going to the wiper system. These should have a drain and oil change at least twice a year.

E. Alcohol injectors are very useful for vehicles operating in severe cold conditions. Precautions should be taken to keep sufficient lubricant in the motor as alcohol will tend to wash it away. If used heavily, it may be necessary to remove the motor valve and manually regrease unit.

WINDSHIELD WIPER ARM AND BLADE REPLACEMENT

During initial installation or spot check, be sure the motor is in full park position. Be sure blade is assembled in the "blade saddle" correctly. Tighten screw and nut assembly until snug. Blade should have free movement in the saddle — do not crush saddle over blade. If saddle portion of arm is not attched to arm, be sure during assembly to place saddle on main wiper arm (larger of two), not on the follower (smaller of two). If not already done, install follower arm and tighten nuts and bolts. Parts should move freely in bearings.

WIPER BLADE ANGLE ADJUSTMENT

Pantograph shaft length is adjustable to allow setting wiper blade angle. Each blade should travel across windshield in a position so that when the arm is at the end of its outward sweep, the wiper blade is parallel with the edge of the windshield. Adjust angle of blade by placing blade rubber 1" from molding while motor is in park position. By hand, move the wiper arm to mid-position (perpendicular) on glass. Place wiper blade in vertical position parallel with main arm.

Loosen lock nuts on pantograph shaft. Remove crown nut which attaches shaft arm to pivot shaft. Remove arm from shaft. While holding outer end of pantograph shaft, turn shaft arm to shorten or lengthen shaft assembly. Reinstall arm on pivot shaft. Force arm and blade across wetted glass and check angle of blade. Repeat if necessary, then install crown nut on pivot shaft and tighten firmly. Tighten lock nuts on pantograph shaft.

Turn motor unit to ON position; take note if wiper pattern is centered and tips of wiper blades are not touching rubber moldings. If the sweep is off center, it will be necessary to move main arm clockwise or counterclockwise on diameter segment to center the sweep. After each change it will be necessary to re-center the blade in mid-position.

MOTOR DISASSEMBLY AND REPAIR

1. Remove windshield wiper blades, arms and pantograph arms.

2. Remove wiper shaft spacer retainer nut. Remove left or right hand corner moldings.

3. Disconnect air lines to wiper motor.

4. Remove wiper motor mounting panel retaining screws and lift out the complete assembly.

MC-9 MAINTENANCE MANUAL

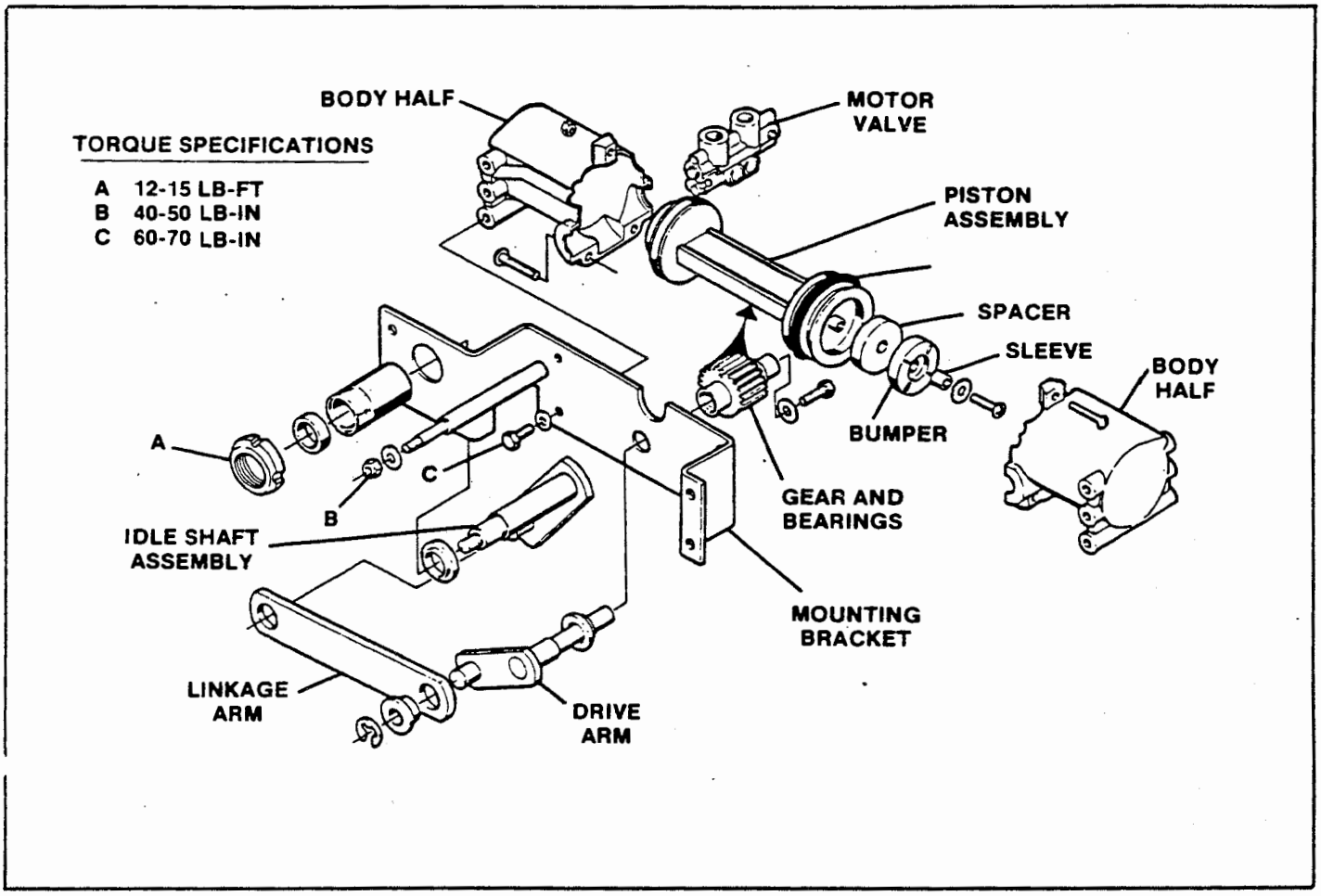


Figure 3-36. Windshield Wiper Motor.

The motor consists of four subassemblies: valve, body (two halves), piston, and shaft and gear assembly. Subassemblies may be replaced as complete units, or they may be disassembled and repaired. See figure 3-36. Follow this procedure to disassemble wiper motor:

1. Remove the three screws holding the body halves together. Holding the shaft in one hand, separate the halves. Note position of motor valve in body half and position of timing marks on gear and rack.

2. Remove the shaft, gear and sleeve assembly. Disassemble the subassemblies accordingly.

3. BODY HALVES: No further disassembly is required.

4. MOTOR VALVE ASSEMBLY: Remove from body half. No further disassembly is required. Replace if necessary with proper valve.

5. PISTON ASSEMBLY: Remove from body halves. Remove O-rings, rubber bumpers and spacers.

6. SHAFT AND GEAR ASSEMBLY: Remove shaft and bearings and check for concentricity. If gear has excessive wear, replace.

7. Clean all metal parts with an approved solvent, inspect for excessive wear and replace where necessary. Check both body halves for excessive scoring and replace if necessary.

8. Always replace main cylinder O-rings and valve body seals when assembling.

NOTE: Blow all air passages clear.

9. Lubricate parts with Sprague Air Push grease only.

10. Assemble the four subassemblies in reverse order.

11. Install motor valve in proper position. Check the assembled motor for excessive air leakage with leak detector and tighten carefully where necessary.

MC-9 MAINTENANCE MANUAL

WINDSHIELD WIPER CONTROL VALVE

Windshield wipers are controlled by two small knobs situated at the lower right side of the instrument panel. Each knob controls its corresponding windshield wiper.

To operate wipers, turn control knob for wiper desired toward direction indicating ON until required speed is reached. To stop wipers, turn knob to OFF position.

REMOVAL

Individual wiper motor control motor valves (figure 3-37) can be removed from the vehicle for cleaning or repair if necessary. Before removing valve assembly, vent air pressure from system.

Remove the four screws (11) which attach cover (3) to the body (1). Separate cover from the body.

Pull parking valve stem (4) with O-ring from the valve body (1). Remove valve spring (5).

Using pliers with a small, thin nose, pull pressure regulating ram (9) with guide washer (10) from the valve body (1). Remove pressure regulating coil spring (8).

NOTE: Do not disassemble valve further if not necessary.

Clean all parts in solvent; then, applying air pressure into valve body ports, blow any dirt and solvent from valve body. Using a soft material object, force valve seat and retainer (7 and 8) back and forth within the body; then repeat cleaning procedure.

NOTE: If retainer, valve seat assembly appear to be damaged, repair or replace entire hand control valve assembly.

Apply small quantity of wiper motor lubricant to valve surfaces and rubber rings. Install valve and check operation.

WINDSHIELD WIPER TROUBLESHOOTING

1. MOTOR WILL NOT OPERATE

   Inadequate air supply to motor

   Solution: Check the air compressor operation and air lines leading to the control valve for contamination, breakage or leaks.

   Defective control valve

   Solution: Check the control valve knob for sticky conditions, or check intake and feeder ports for blocked operations. Also check O-rings in control valve for leaks, and air lines leading from control valve to motor for air leaks, contamination or breaks.

1. Body Assembly
2. Cam
3. Cover Cap
4. Parking Valve Stem Assembly
5. Spring
6. Valve Stem
7. O-Ring Retainer
8. Spring
9. Pressure Regulating Ram
10. Guide Washer
11. Screw
12. Plastic Knob
13. Cam Rod
14. O-Ring
15. Nut

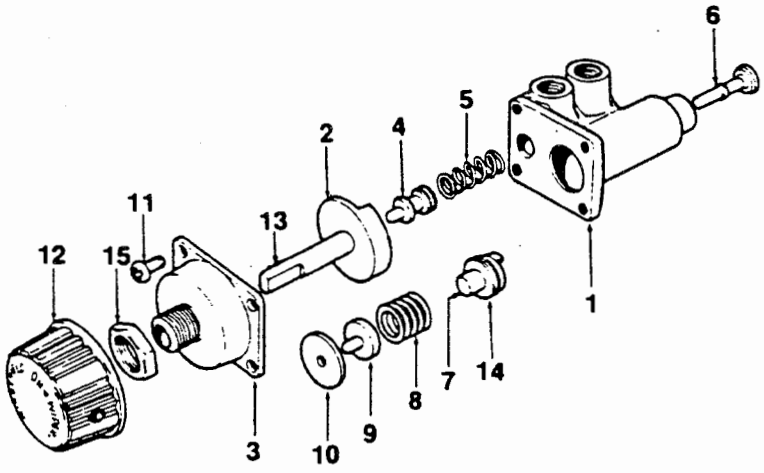


Figure 3-37. Wiper Control Valve.

Defective motor valve

Solution: Check the primary and secondary valve rods to see if they are binding in the chambers. Check for defective O-rings on the rods.

Clogged air passages in motor

Solution: Disassemble the motor and clear air passages.

Linkage locked up

Solution: Check that transmission shaft has been properly inserted. Also check drive pin for excess wear and proper lubrication. Check to see if linkage is hitting against the coach window side. This may be due to improper size drive bar or pin, pulling linkage out of proper line of travel.

Motor is getting air, but shaft is not turning

Solution: Check all drive components for broken valve pin, gear or rack. Also, examine gear and rack for excessive wear which may be making improper gear engagement. If a tapered shaft is used, check to see if it has broken loose from the gear.

2. MOTOR OPERATES BUT WIPER ARM DOES NOT MOVE

Shaft is operating but arm does not move

Solution: Check if arm driver is cracked, or has become disengaged through wear or some other cause.

3. MOTOR OPERATES AT LESS THAN FULL POWER

Air leak in the Control Valve

Solution: Check O-rings for wear or flat spots.

Air leak in the Wiper Motor

Solution: Examine the large O-rings on piston rack for wear or flat spots. Also, examine the cylinder walls of the motor to see if they are scored to allow air to bypass the O-rings.

4. MOTOR OPERATES IN AN ERRATIC MANNER

Reverser "T" drilled off center, not drilled deep enough, or it may hang up on reverser rod

Solution: Disassemble motor and examine reverser "T" to see if the hole for the valve pin is drilled on center and deep enough to allow full acceptance of pin. If "T" is hanging up on rod, lubricate the "T" and examine bore for flash. Examine rod for sludge deposit which could cause "T" to stick.

O-rings fit too tightly in bore of motor valve

Solution: Disassemble motor valve by removing the end plates. Examine primary and secondary valve rods to see if any O-rings show a high spot or complete oversize.

O-rings too tight in main cylinder bore

Solution: Examine large O-rings on piston assembly for high spots or complete oversize. Also, examine cylinder wall bore to see if there is dirt or sludge on which piston may be sticking.

Exhaust ports plugged

Solution: Examine ports to see if plugged or blocked. Clean and clear them to allow free escape of air from motor.

Unused parking end plate plugged

Solution: If motor valve has parking end plate on both ends, check to see that the unused park end plate is not plugged.

5. SLAMMING ACTION BY ARM ON ONE SIDE OF SWEEP

Loss of pressure at one end of cylinder, causing no back pressure on returning swing of motor

Solution: Replacement of main O-ring. Clean port to allow air passage to maintain proper air pressure in cylinder. Examine O-rings on primary and secondary rods and replace if worn.

6. MOTOR SWEEPS "SHORT" IN ONE DIRECTION

Reverser "T" drilled off center

Solution: Disassemble motor and examine reverser "T" on reverser rod. Hole for valve pin must be drilled on center.

Defective primary valve rod

Solution: Remove primary valve rod from motor valve and see if the rod is sticking due to sludge or residue in bore cylinder. Clean bore and lubricate. Check and replace improperly sized or worn O-rings.

Defective cylinder or cylinder O-ring

Solution: Disassemble motor and examine large O-rings on piston rack for wear. Examine cylinder wall for sludge which would cause piston to stick or stop short of full travel. Check cylinder wall for defects or cracks which could stop the piston travel.

7. MOTOR OVERSWEEPS (OFF THE GLASS)

Worn transmission gear rack in motor

Solution: Disassemble motor and check gear and rack for wear. Replace worn parts.

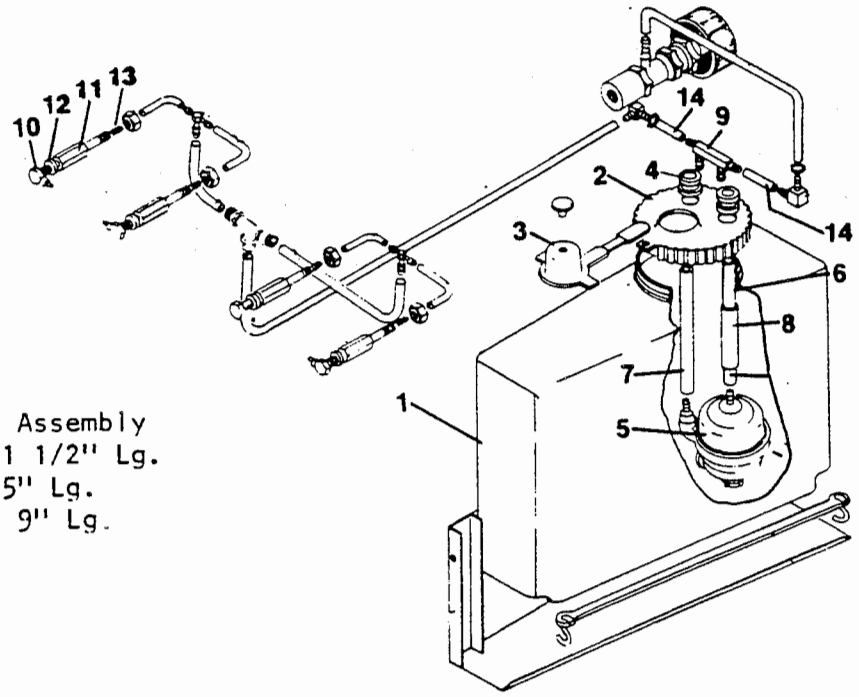
Piston stops worn or broken

Solution: Examine piston rack to see if piston stops on the reverse rod are still proper length. Replace as necessary.

Worn arm pivot points, causing arm to slip on shaft when shaft stops

Solution: Examine the shaft first to be sure it is not slipping in the gear. If not, examine the point when the shaft attaches to the arm. See if arm driver is worn or broken. If so, replace arm or arm driver.

MC-9 MAINTENANCE MANUAL



1. Reservoir
2. Cover
3. Umbrella Valve
4. Rubber Grommet
5. Diaphragm Chamber Assembly
6. Rubber Tubing - 11 1/2" Lg.
7. Rubber Tubing - 15" Lg.
8. Plastic - Tubing, 9" Lg.
9. Purge Tee
10. Nozzle Assembly
11. Nozzle Tower
12. Gasket
13. Hose Fitting
14. Hose - 9/64" I.D. x 28" Lg.

Figure 3-38. Windshield Washer Solution Tank.

WINDSHIELD WASHERS

The three-gallon (11.4 liter) polyethylene windshield washer fluid reservoir is in the left front service compartment below the driver's floor. Two outlet nozzles are located below each half of the windshield and are adjustable 360° vertically and horizontally. Lines are purged automatically before and after each spray cycle, eliminating freezing or clogging of lines and nozzles. A closing plate is provided on top of the reservoir for refilling purposes.

WINDSHIELD WASHER CONTROL VALVE

Air-operated windshield washers have an independent washer control knob on the lower right side of the instrument panel alongside the two windshield wiper knobs.

To operate windshield washers, press control knob. The washers will operate for a period of time while the control knob is held in this position. Release knob for approximately ½ minute to allow pump to refill before operating windshield washer again. Turn windshield wipers on when using windshield washers.

REMOVAL

1. Before removing washer control valve, vent air pressure from system.
2. Disconnect the air lines and mark lines for identification when assembling.
3. Loosen set screw and remove knob.
4. Remove nut and washer from the plunger rod. Remove valve assembly from dash.

Reverse procedure to install.

WINDSHIELD WASHER TROUBLESHOOTING

1. FAILS TO EMIT WASHER SOLUTION

Reservoir empty
Solution: Add proper fluid.

If below 32°F (0°C) improper washer fluid-frozen
Solution: Store vehicle or parts in heated area. Then purge system with low-temperature solution.

Contamination in tubing or nozzles
Solution: Remove with compressed air. If severely clogged, replace items.

Tubing damage
Solution: Replace section.

Tubing bent (kinked) or off one or more connections
Solution: Realign tubing and/or refit. Trim end to ensure proper fit or replace.

2. CONTROL VALVE FAILS TO OPERATE
Vehicle air system low
Solution: Establish a minimum of 90 psi (621 kPa).
Vehicle air pressure inadequate — air to valve below 90 psi (621 kPa).
Solution: Check lines for kinks.

Air pressure from valve outlet below 35 psi (241 kPa).
Solution: If air pressure to valve is correct, check for clogged inlet port. If clear, replace valve.

3. CONTROL VALVE OPERATIVE BUT SYSTEM INOPERATIVE
Diaphragm damaged
Solution: Replace valve.

4. INADEQUATE EXPULSION OF WASHER SOLUTION
Tubing failure
Solution: Replace tubing.

5. AIR LINES BLOWING
Damaged tubing
Solution: Replace tubing.

6. SLOW OPERATION
Inadequate air pressure
Solution: Check air system.

Improper solution
Solution: Replace with proper type solution.

7. JET STREAM IMPROPERLY DIRECTED
Solution: Reposition nozzles.

8. DIAPHRAGM DOESN'T REFILL
Faulty diaphragm
Solution: Replace diaphragm.

Faulty control valve
Solution: Replace control valve.

Valve assembly atop the reservoir is stuck in the open position
Solution: Remove, clean and lubricate or replace.

DESTINATION SIGN

DESCRIPTION

The destination sign is located above the front windshield. An optional side destination sign is mounted on the right hand front side of the coach.

MAINTENANCE

It is recommended that the following inspections and checks be made on a regularly scheduled basis:

1. Check to see if mechanism runs free and easy. Crank handle on destination sign; if it seems to bind, check gears for lodgement of foreign objects.
2. Check for loose items such as wires, clips, hanging tape, etc. Repair or remove such items.
3. Inspect the inside of the destination sign compartment. Remove dirt and foreign objects. Clean inside of compartment well and keep door closed.
4. If curtain is loose on rollers, run curtain to one end and turn crank handle until curtain roll is tight on roller. Run actuating mechanism through full cycle of curtain and repeat tightening action on opposite end of curtain.
5. The destination sign mechanism has nylon gears; therefore, no lubrication to the mechanism is required.

SIGN CURTAIN REPAIR

In the event a destination sign curtain is torn, it can be repaired with 3M polyester tape or any equivalent cellophane tape. When repairing a tear, the tape should be used on both sides of the curtain.

When it becomes necessary to install or add curtain inserts, butt splice or overlap and apply strip of ¾" (19.0 mm) wide polyester tape over front and rear seam.

The above method is an easier and more accurate way of installing inserts than the sewn methods. It also makes for considerably less bulk and better turning of curtain rolls.

DRIVER'S SEAT

The driver's seat may be adjusted fore and aft by pushing in the lock lever located at left front of seat. When seat is positioned, release the lever. The back of the seat cushion can be tilted up or down by grasping the large knob at left corner of driver's seat and turning forward to lower and backward to raise. Seat may be raised by grasping and firmly pulling seat frame up. To lower, raise seat to highest position, then lower seat to lowest position. From there raise seat to desired height.

MC-9 MAINTENANCE MANUAL

SEAT BELT

WARNING: Seat belt is to be used at all times when coach is in motion.

The seat belt is self-adjusting and equipped with a recoil-lock mechanism. In case the reel operation becomes "sluggish" lightly spray it with aerosol lubricant while holding the belt fully extended.

MAINTENANCE OF SEAT BELTS

The seat belt mounting must be inspected for looseness at least twice a year. If it becomes necessary to clean the webbing, use a mild detergent with lukewarm water. Do not re-dye or use solvent type cleaners on webbing. This may weaken the fibers or affect the original dye. When fraying takes place, replace belt.

EXTERNAL REAR VIEW MIRRORS

DESCRIPTION

Two exterior rear view mirrors are installed on the coach, one on the left hand side and one on the right hand side. The mirrors have replaceable glass and can be easily replaced if broken. To prevent breakage of the windshield glass and driver's window by sudden slamming, adjustable bumper stops are installed in the mirror mounting brackets. Also, four (4) rubber bumpers are installed in each left and right hand mirror bezel to prevent glass breakage.

ADJUSTING MIRROR HEAD

At the bottom end of the mirror arm (23,31) tighten or loosen socket head screw (30,38) which will tighten or loosen tension

1. R.H. Bracket
2. Stud
3. Rollpin
4. Rubber Bumpers - Brkt.
5. Nut - Bumper Retaining
6. Washer
7. Spacer
8. Spring Washers (4)
9. Nut - Self-Locking
10. Washer
11. Cap
12. L.H. Bracket
13. Stud
14. Rollpin
15. Rubber Bumpers - Brkt.
16. Nut - Bumper Retaining
17. Washer
18. Spacer
19. Spring Washers (4)
20. Nut - Self-Locking
21. Washer
22. Cap
23. R.H. Arm
24. Spring Retainer
25. Spring
26. Seat
27. Ball Stud
28. Retaining Cap
29. Machine Screw
30. Set Screw
31. L.H. Arm
32. Spring Retainer
33. Spring
34. Seat
35. Ball Stud
36. Retaining Cap
37. Machine Screw
38. Set Screw
39. Bezel
40. Glass
41. Back - R.H.
42. Back - L.H.
43. Rubber Bumpers - Bezel
44. Set Screw
45. Heating Element
46. Convex Mirror

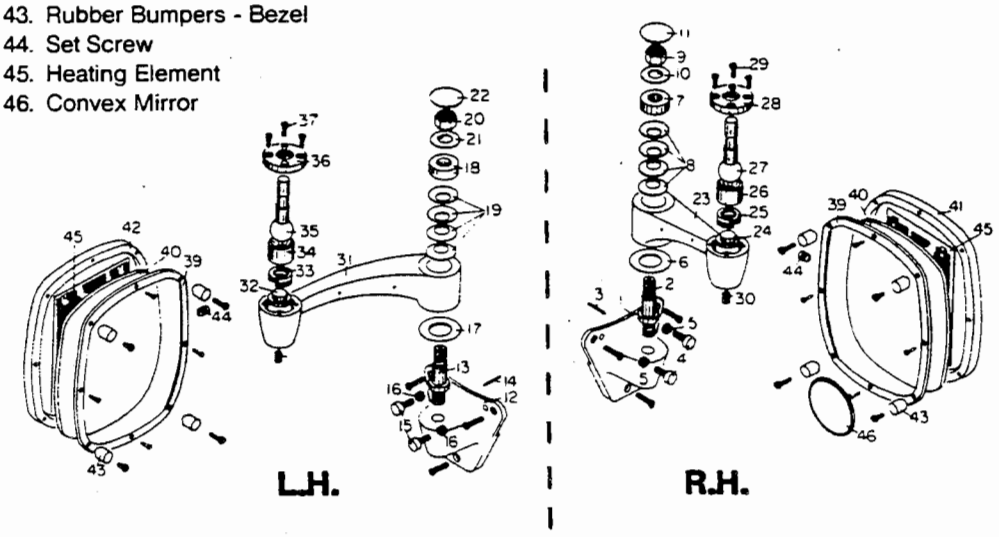


Figure 3-39. External Rear View Mirrors.

n the mirror head ball stud (27,35). If necessary, loosen or tighten the set screw (44) on the side of the mirror head to facilitate the adjustment. The mirror arm can be disassembled and tension components replaced or repaired.

ADJUSTING ARM TO BRACKET TENSION

At body end of mirror arm (23,31) remove the caps (11,22) to expose the self-locking nut (9,20). Tighten or loosen nut to desired tension. If necessary, arm can be disassembled and tension components replaced.

ADJUSTING MIRROR ARM STOPS

On the mirror arm brackets (1,12) loosen the lock nuts retaining the bumper stops (4,15). With the mirror arm to bracket tension slack, swing the arm to the extreme end of travel, touching coach body, windshield or window glass. Turn out bumper stops to provide sufficient clearance to prevent glass, body or mirror damage. Secure bumper stops by tightening lock nuts.

DISASSEMBLY OF MIRROR ARM

At mirror end of arm, loosen set screw (30,38) to relieve spring tension on ball stud (27,35). Remove the four screws (29,37) attaching ball stud cap (28,36) to arm. Remove the cap, ball stud, ball stud seat (26,34), spring (25,33), and spring retainer (24,32) from the arm. At the bracket end of arm, remove cap (11,22), nut (9,20), washer (10,21), spacer (7,18), and spring washers (8,19). Remove arm from stud. Assembly is reverse of disassembly procedure.

REPLACEMENT OF MIRROR GLASS

Remove the eight screws which attach the bezel (39) to the mirror head. Then with a thin blade pry bezel from head. Remove broken mirror glass, then position new glass with tape in mirror head. Position bezel over glass and secure with eight screws.

IMPORTANT: Tighten screws evenly and firmly.

HEATED EXTERNAL REAR VIEW MIRRORS (OPTIONAL)

Heated external rear view mirrors may be provided to prevent the mirrors from frosting up in cold weather. A heating element is installed inside both mirrors and is activated by a switch located on the left of the driver on the switch panel.

The switch is wired in series with the Coach Heat switch; therefore, both must be activated before the mirror heating element will energize. Once energized, the mirror heating element is kept at a sustained temperature by a heat regulated disc thermostat. See figure 3-40. A wiring diagram can be found in section 7 of this manual.

To service the mirror glass or the heating element, refer to the previously described procedures for servicing the mirror glass in the nonheated style mirrors.

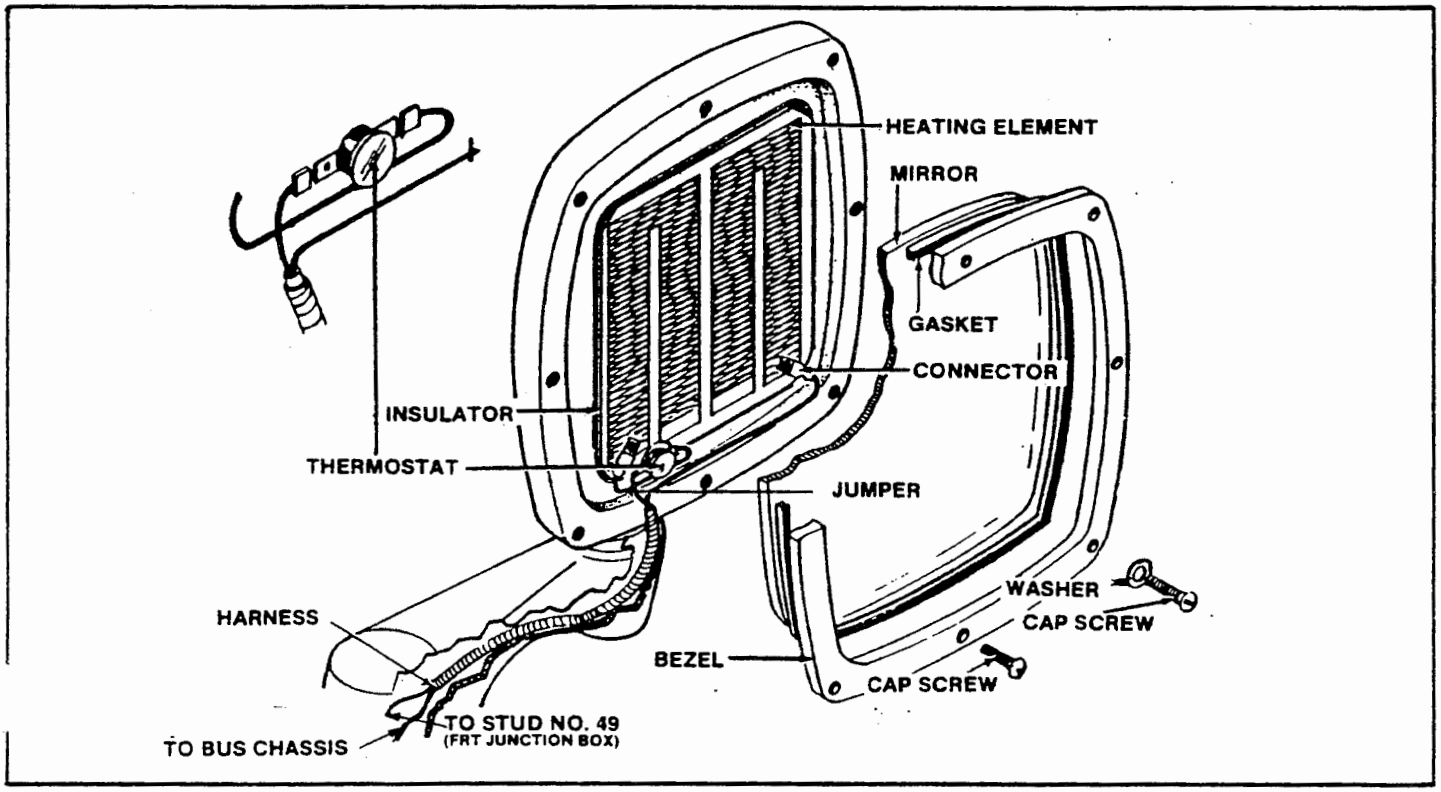


Figure 3-40. Heated Rear View Mirror.

RETRACTABLE ENTRANCE STEP (OPTIONAL)

The air operated retractable step permits easier passenger boarding by providing an additional step below the lower coach step. Step height is 8½" (216 mm). It is shown in figure 3-41.

The retractable step is controlled by a Step In-Out switch located on the driver's switch panel.

OPERATION

When the step is in the retracted position (no voltage applied), air pressure is automatically applied through the four-way valve to the "in" side of the air cylinder, thus holding the step in. A locking air cylinder extends through two aligned holes in the step assembly to lock it in place only when coach air pressure is below approximately 75 psi (517 kPa).

The step can only be extended if all of the following conditions are met:

A. Coach air pressure is above 75 psi (517 kPa).
B. Park brake is in the ON position.
C. Entrance door is open.
D. Step switch is actuated in the OUT position.

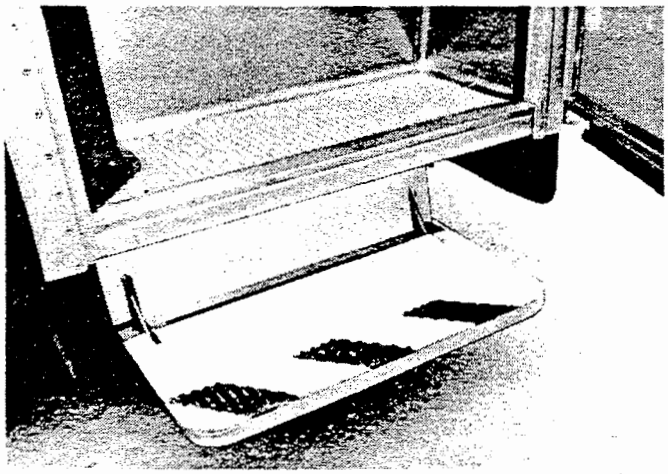


Figure 3-41. Retractable Entrance Step.

This will energize the four-way valve and the step relay. The four-way valve then applies air in order to extend the step and exhaust air from the "in" side. The Step-Out tell-tale light located in the driver's instrument panel will illuminate.

Anytime the step switch is turned to the IN position, the park brake is pushed into the OFF position, or the entrance door is closed securely, power will be removed and the step will retract. Any one of these situations breaks the supply voltage to the four-way valve, thus de-energizing the relay and causing relay contacts to fall open. Simultaneously, the shutting off of power will automatically cause the four-way valve to reverse the air to the step, thus pushing it "in" and exhausting the "out" position.

Because the relay contacts have fallen open, the Step Out tell-tale light will go out.

Anytime the air pressure drops below 60 psi (413.68 kPa), a locking air cylinder will not permit operation of the step. Air pressure this low is considered unsafe to operate the step.

NOTE: In order to retract step when lock cylinder is engaged, the system must be cycled.

SERVICING INDIRECT LIGHTS

1. When servicing the indirect lights, first remove the gray vinyl snap-in molding by inserting a flat tip screwdriver under the lip of the molding (near molding joint).
2. Pry the molding from the housing track (see photo).
3. Remove lens to expose the bulbs for the indirect lights.
4. To replace lens, first position lens in the housing groove.
5. Then position molding in the housing track and push up to snap lock molding.

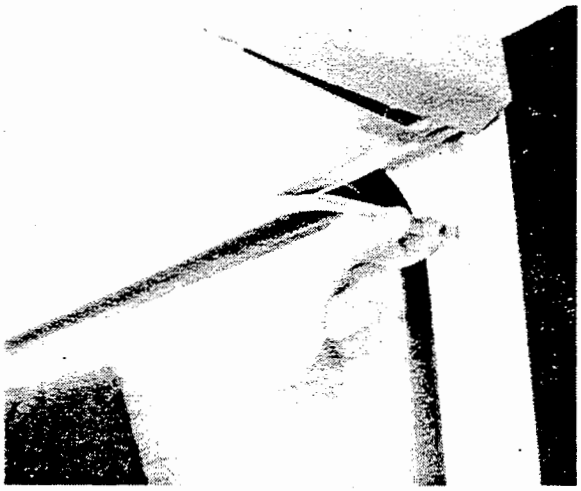


Figure 3-42. Servicing Indirect Lights.

SERVICING IN-STATION LIGHTS

1. Remove lens by inserting a flat-tip screwdriver behind lens at notch in end of light housing (see figure 3-43).
2. Apply downward pressure on lens until lens is disengaged from housing grooves.
3. To replace lens, first position lens in one groove in housing assembly.
4. Then apply upward pressure along center of lens until lens snaps into place in opposite housing groove.

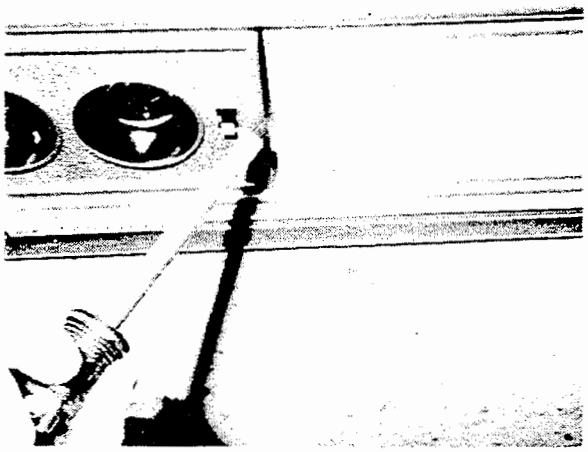


Figure 3-43. Servicing In-Station Lights.

MC-9 MAINTENANCE MANUAL

MAXI GALLEY

DESCRIPTION

The optional maxi galley is located at the rear of the coach along the number 6 and 7 left hand side sash assemblies. The galley cabinet is constructed of ¾-inch plywood and contains the following components:

- a four cubic foot absorption type refrigerator complete with freezer compartment.
- three hot/cold liquid containers.
- a multiplex AM/FM radio, cassette stereo system with public address.
- a large countertop work area complete with fluorescent lamp.
- five keyed-alike locking cupboards with a storage capacity of seventeen cubic feet.
- a 2½-pound fire extinguisher.
- a coat rack.
- a hostess seat (optional).

The refrigerator and liquid containers may be powered by either the 24-volt DC coach electrical system or, to conserve the coach batteries, the 110-volt AC in-station electrical system. The liquid containers will switch from one power source to the other automatically; however, the refrigerator must be manually converted. This is accomplished by flipping the toggle switch on the galley cabinet to the desired power source. Tell-tale lights are provided on the galley switch panel to indicate which power source is being used. The stereo system is powered by 24-volt coach electrical system only.

NOTE: To prevent excessive battery discharge, it is recommended that the stereo system be operated only when the coach is running.

Access to most of the maxi galley wiring is made possible by opening the #7 left hand side sash. To inspect the wiring on the galley switch panel, it is necessary to remove the mounting screws and carefully pull the panel away from the cabinet.

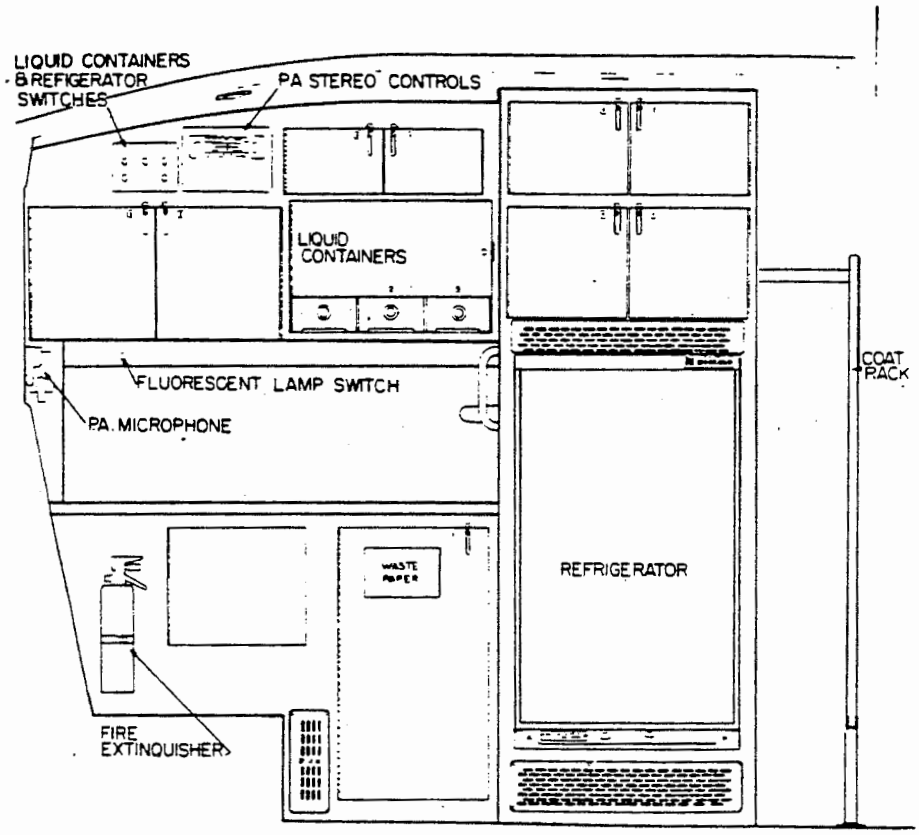


Figure 3-44. Maxi Galley.

MC-9 MAINTENANCE MANUAL

LIQUID CONTAINERS

Three insulated liquid containers, each fitted with a thermostatically controlled heating element, are contained within the maxi galley cabinet. The containers are of stainless steel construction and each one has a capacity of 2 U.S. gallons (7.6 liters). They are provided for keeping coffee, soup and other hot beverages at a temperature of between 170° and 190°F (77°-88°C). By turning the switch at the hostess station "OFF" and placing ice in the center ice well of the liquid container, the insulated containers become suitable for storing cold beverages. Without power and an initial temperature of 180°F (82°C) liquids may be held for up to five hours before the temperature falls below 140°F (60°C).

The liquid containers can be powered by either the 24-volt DC coach electrical system or, to conserve the coach batteries, the 110-volt AC in-station electrical system. There is no manual voltage selection necessary, as the switching control box automatically switches from 24 volts to 110 volts when the in-station electrical system is plugged in and back to 24 volts when unplugged.

REMOVAL OF LIQUID CONTAINERS

The removal of the liquid containers is necessary to clean or fill them, or in the event that a spigot or heating element needs replacing.

To remove the containers, release the spring-loaded catch and open the door at the front of the liquid containers. Lift the front of the container high enough to clear the tray and pull the container forward. When installing, slide the container into position and push firmly to ensure that the self-aligning three-pin plug makes full contact. There are two screws on the female plug bracket, should adjustment of the plug be necessary.

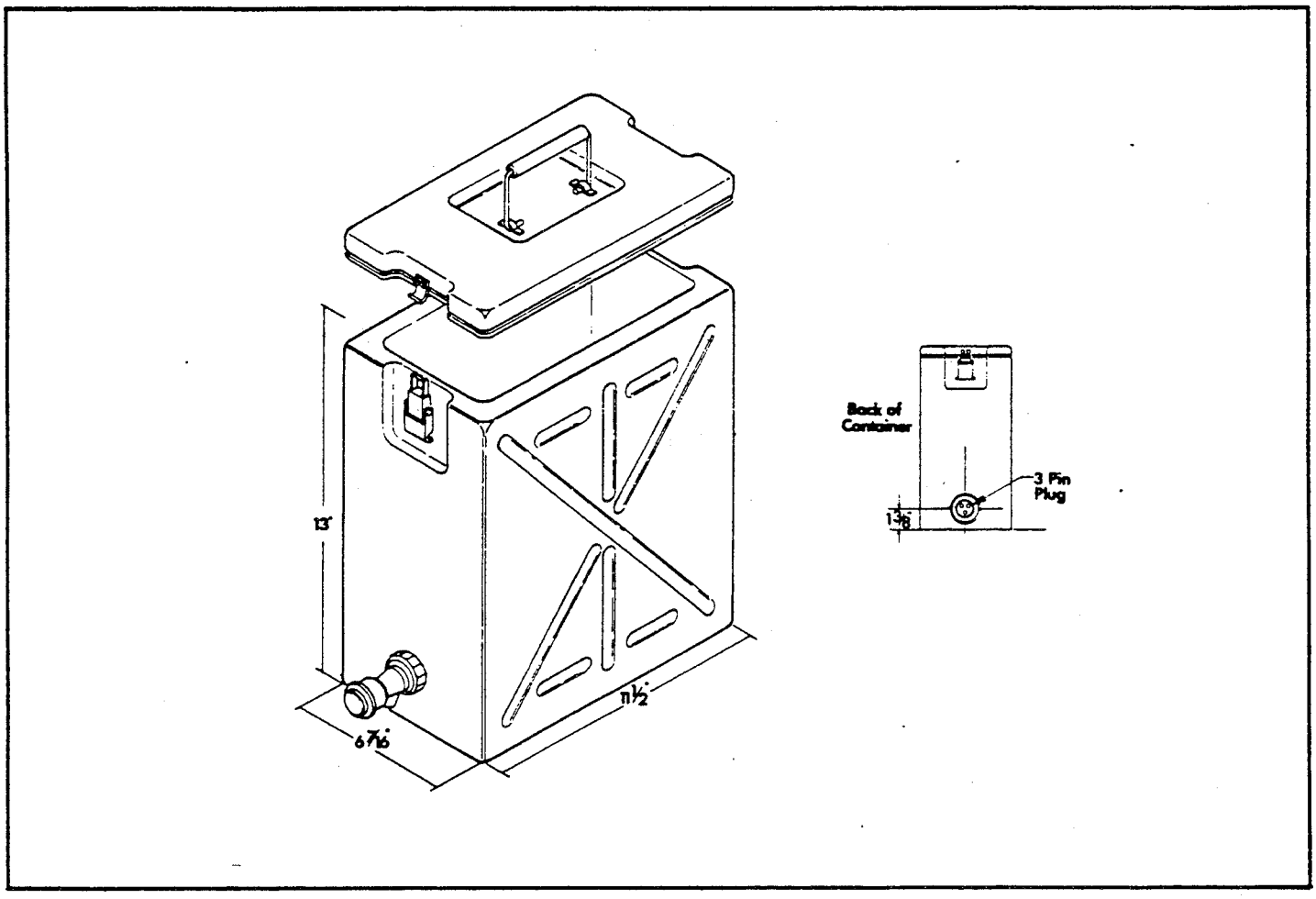


Figure 3-45. Liquid Containers.

MC-9 MAINTENANCE MANUAL

REFRIGERATOR

The maxi galley comes equipped with a Norcold Model 776-EG3 absorption type refrigerator, which is fitted into the front lower section of the cabinet assembly. Measuring 40½" (102.87 cm) high x 22" (55.88 cm) wide x 22-11/16" (57.62 cm) deep, the refrigerator has a storage capacity of 4 cubic feet. Other features of the refrigerator include: an adjustable shelf, a deep full width crisper, in-door storage, and a separate freezer compartment with two ice trays.

CAUTION: Turn refrigerator off before charging batteries.

REMOVAL OF REFRIGERATOR

1. Turn the main battery switch "OFF."
2. Open the trash bin door on the galley. Reach in and lift the release bar to open the window behind the maxi galley.
3. Prop open the window from outside of the coach to gain access to the maxi galley electrical components.
4. Disconnect the red wire of the refrigerator feeder harness from stud #8 of the ten terminal stud block
5. Disconnect the white wire of the refrigerator feeder harness from stud #10 of the ten terminal stud block.
6. Disconnect the green wire of the refrigerator feeder harness from the terminal near the bridge rectifier.
7. Remove and retain the three clamps that secure the refrigerator feeder harness.
8. Remove the clamp that secures the three-prong plug cable and unplug the refrigerator. Return to the inside of the coach to complete the removal procedure.
9. Remove the four retaining screws from the outside flanges of the refrigerator.
10. Remove the upper grill from the galley cabinet.
11. Carefully remove the refrigerator from the cabinet.

REFRIGERATOR TROUBLESHOOTING

If the outside of the refrigerator is warm but the refrigerator has not been cooling for an extended period of time, the cooling system is blocked. Refer to **Procedure #1** to correct a blocked system.

Procedure #1

For proper operation of the absorption system, it is necesary for the ammonia and water to mix together. If the refrigerator is not kept in a level position, the ammonia will boil out of the water, causing a blocked system. To remedy this situation, remove the refrigerator from the coach and place it on its left side for one hour. This will allow the water and ammonia to mix together.

Install the refrigerator and operate it for one to two hours to determine if the cooling process has been restored. If the refrigerator is not cooling after this time and **Procedures 2** through **6** have determined that all electrical systems are functioning properly, the cooling system must be removed and replaced.

24-Volt Operation

If the refrigerator is not cooling properly while operating on 24 volts, the following series of tests should be performed to determine where the problem eixsts.

Procedure #2

With the main battery switch "ON" and the refrigerator switch at the hostess station in the "24 VOLT" position, proceed as follows:

1. Open the trash bin door on the galley. Reach in and lift the release bar to open the window behind the maxi galley. Prop the window open to gain access to the electrical components at the rear of the galley.
2. Using a voltmeter, determine if 24 volts is present at stud #1 on the ten terminal stud block. If 24 volts is present at stud #1, proceed to step 3. If 24 volts is not present, check the 20-amp circuit breaker in rear junction box. If 24 volts is not present at the circuit breaker, it should be replaced.
3. Determine if 24 volts is present at stud #8 on the ten terminal stud block. If no voltage is present, the refrigerator switch at the hostess station is defective and should be replaced. If 24 volts is prsent at stud #8, turn the main battery switch "OFF" and continue with step 4.
4. Open the refrigerator door. Inspect the fuse in the fuse holder, located on the refrigerator control panel, and replace it if it is burned out.
5. Turn the main battery switch "ON" and allow the refrigerator to operate for about five minutes.
6. After five minutes, flip the refrigerator switch at the hostess station "OFF" and inspect the fuse again. If the fuse is burned out, continue with **Procedure #2.** If the fuse is not burned out, reinstall it, flip the refrigerator switch at the hostess station to "24 VOLTS" and close the refrigerator door. Periodically check the freezer compartment to determine if the refrigerator is cooling properly. If the refrigerator is not cooling after 1 to 2 hours, continue with **Procedure #4.**

Procedure #3

If after **Procedure #2 step 5,** the refrigerator fuse burned out, perform the following inspection:

1. Remove the refrigerator from the cabinet; refer to REMOVAL OF REFRIGERATOR.
2. Disconnect the yellow and black feed wires from the refrigerator heater element feed wires.
3. Using an ohmmeter set on the R x 1 scale, check the yellow and black lead wires to the heater element. If a reading of 3.6 ohms (±.2 ohms) is not attained, the heater element is defective and should be replaced.
4. If a reading of 3.6 ohms (±.2 ohms) was attained in step 3, a short exists between the heater element and the 15A fuse. Inspect all connections between the heater element and the fuse and eliminate the cause of the short.

Procedure #4

If the fuse was not burned out after **Procedure #2 step 6,** and the refrigerator is not cooling after 1 to 2 hours of operation, proceed with the following:

1. Turn the main battery switch "OFF."

2. Remove the refrigerator from the cabinet; refer to REMOVAL OF REFRIGERATOR.

3. Disconnect the yellow and black feed wires from the refrigerator heater element lead wires.

4. Using an ohmmeter set on the R x 1 scale, check the yellow and black leads of the heater element. A reading of 3.6 ohms (±.2 ohms) indicates that the heater element is functioning correctly. If no resistance or very high resistance is found, replace the refrigerator heater element.

5. If the heater element is functioning correctly, place one ohmmeter probe on the black feed wire that was disconnected from the heater element. Place the other probe on the white (negative) 24V feed wire that was disconnected from stud #10 of the ten terminal stud block. If there is infinite resistance, adjust the thermostat control to either extreme while observing the ohmmeter scale. If the ohmmeter registers any resistance while adjusting the thermostat, the circuit is functioning correctly. If the ohmmeter registers no resistance while adjusting the thermostat, proceed to step 6.

6. Remove the four screws that secure the control panel to the refrigerator and remove the panel.

7. Place the probes of the ohmmeter across both terminals of the thermostat and then across both terminals of the snap switch.In either case, little or no resistance indicates that the component is functioning correctly. If there is very high or infinite resistance, replace the faulty component.

110-Volt Operation

If the refrigerator is not cooling properly while operating on 110 volts, the following series of tests should be performed to determine where the problem exists.

Procedure #5

1. Remove the refrigerator from the coach; refer to REMOVAL OF REFRIGERATOR.

2. Plug the 110-volt refrigerator cord into an alternate 110-volt socket.

NOTE: When the refrigerator is plugged in, there should be an audible "CLICK." If no "CLICK" is heard, the 110-volt supply cord is faulty and should be replaced.

3. Allow the refrigerator to operate for 1 to 2 hours. If the refrigerator is cooling properly after this time, the problem lies in the coach wiring. If the refrigerator is not cooling and the outside of the unit is warm, the cooling system is blocked. Refer to **Procedure #1** to correct a blocked system. If the refrigerator is not cooling after performing **Procedure #1,** continue with **Procedure #6.**

Procedure #6

With the refrigerator removed from the coach and plugged into an alternate 110-volt outlet, proceed as follows:

1. Using a voltmeter set on the appropriate AC scale, carefully measure the line voltage (110-120 volts) on the red and black lead wires of the refrigerator heater element. If no voltage is present, adjust the thermostat control from one extreme to the other while observing the voltmeter scale. If voltage is present while adjusting the thermostat, proceed to step 2. If voltage is not present, proceed to step 3.

2. Unplug the refrigerator from the AC outlet and disconnect the red and black feed wires from the heater element lead wires. Using an ohmmeter set on the R x 1 scale, measure the resistance on the red and black lead wires of the heater element. If the resistance is not 72 ohms (±3 ohms), the heater element should be replaced.

3. If there was no voltage present after step 1, unplug the refrigerator, remove the four screws that secure the control panel, and remove the control panel.

4. Plug the refrigerator into a 110-volt AC outlet. Using a voltmeter set on the approrpiate AC voltage scale, measure the voltage across relay contacts #8 and #11. If no voltage is present, the relay is defective and should be replaced. If line voltage (110-120 volts) is present, this indicates that either the thermostat or the snap switch is defective. Check both components with an ohmmeter. Whichever one has very high, or infinite, resistance is the faulty component and should be replaced.

After performing all of the electrical tests, it may be determined that the cooling system of the refrigerator needs replacing. In such cases, TMC/MCI recommends that the unit be repaired by professional refrigerator service personnel.

MC-9 MAINTENANCE MANUAL

MINI GALLEY

DESCRIPTION

A mini galley is available as optional equipment on MC-9 Coaches. Its major components are a refrigerator, twin coffee warmers, a cup dispenser, a drip tray, a storage cupboard, and a switch panel. The unit is fitted at the rear of the coach between the lavatory and rear seat. It is designed to operate on both the 24-volt DC coach electrical system and a 110-volt AC in-station power supply.

DRIP TRAY

The hostess center is fitted with a molded fiberglass drip tray and stainless steel rack to catch spigot drippings and the runoff from overfilled cups.

The drip tray drains into a small plastic jug located in the storage cupboard. Because of the jug's small (2 liter) capacity, it should be emptied and rinsed after each trip.

CUP DISPENSER

The cup dispenser is mounted between the two coffee warmers. To refill, remove by grasping the cylinder and pushing toward rear of coach. This will slide it out of its mounting bracket. Once released from mounting bracket, it can be filled with a line of stacked cups (bottom down) and replaced.

COFFEE WARMERS

The coffee warmers are similar to those used in the maxi galley. By turning the element "OFF" at the switch panel, the insulated containers are suitable for storing cold beverages.

The warmers can be run off the 24V DC coach electrical system or off the 110V AC in-station electrical system to conserve the coach batteries. Unlike the refrigerator, there is no manual voltage selection necessary. The power switching controller box automatically switches from 24V to 110V and back again.

To remove the containers, slide the locking lever on the switch panel, grasp the spigot, and pull the container out. The containers can then be washed and filled. To reinstall, again move the locking lever and slide the container in. Push firmly to ensure that the self-aligning three-pin plug makes contact. There are two phillips screws on the female plug bracket for adjustment of alignment. The heating elements and spigots are replaceable.

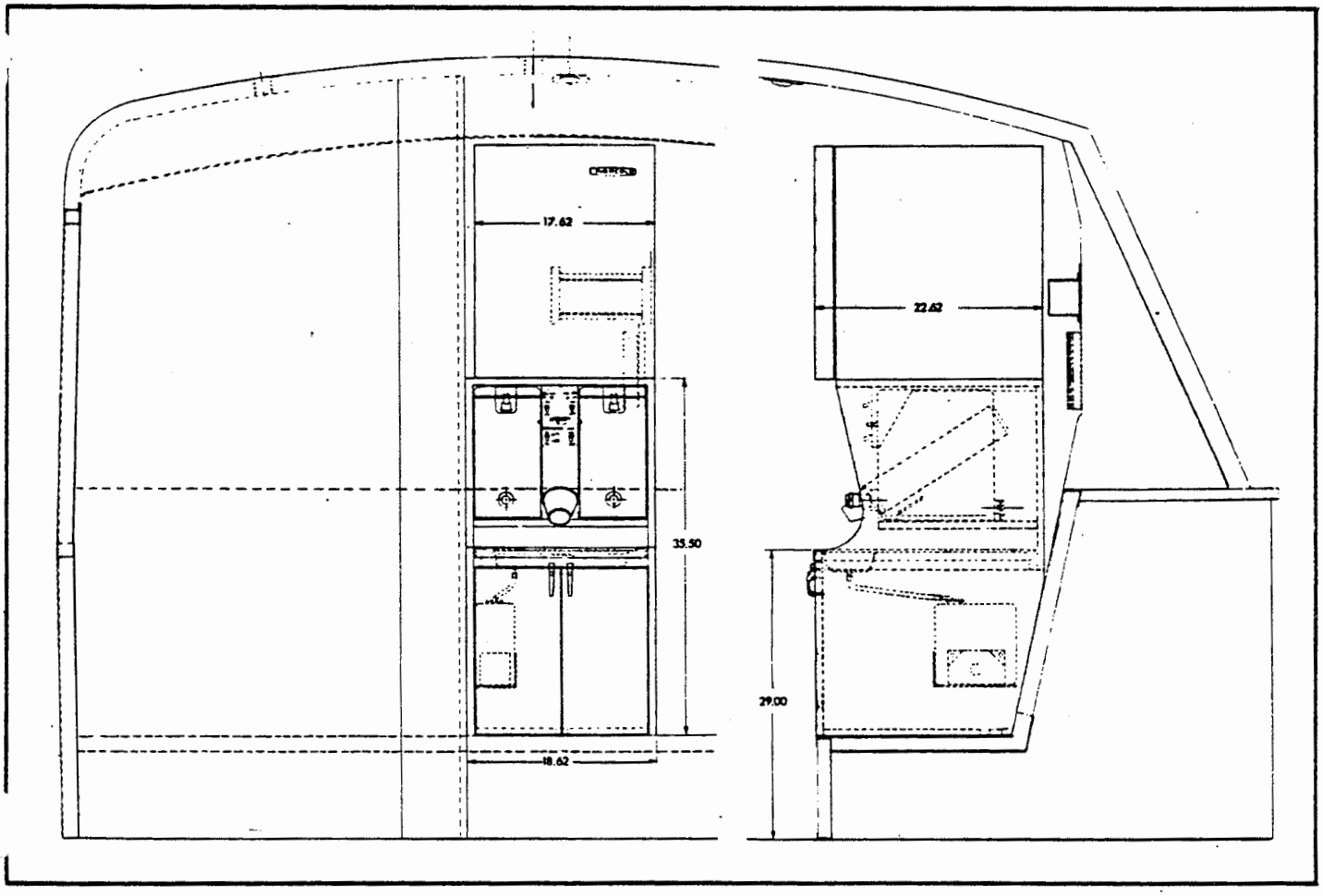


Figure 3-46. Mini Galley.

MC-9 MAINTENANCE MANUAL

REFRIGERATOR (NORCOLD DE-250E)

The refrigerator is a compact 110-volt AC/12-volt DC unit with a 1.84 cubic foot (52 liter) capacity. It is hooked up to the 24-volt coach electrical system through a power converter.

The refrigerator can be turned off either at the switch panel or at the thermostat located inside the refrigerator. The thermostat also is provided with a reverse-polarity circuit breaker to guard against improper hook-up.

The refrigerator can also be run from 110-volt AC power supply to conserve the coach batteries, or to maintain refrigeration when the master switch in the battery compartment is turned off. To use the 110-volt supply, complete the in-station hook-up and set the switch panel to the 110-volt position. If not switched to 110V, the unit will continue to run on 24V. When returning to the 24-volt mode, the switch must be reset to the 24-volt position or no power will be supplied to the refrigerator. If desired, the refrigerator can be powered from the 24V coach power system even if an in-station hook-up has to be made.

NOTE: Turn refrigerator off before charging batteries.

The storage volume of the unit is 1.84 cu. ft. (52 liters) at a standard temperature automatically controlled at 41°F ± 4°F (5°C ± 2°C) at an ambient temperature of 90°F (32°C). The cooling unit is a swing motor hermetically sealed compressor, with an air-cooled condenser, aluminum evaporator, operation on AC 20 volt, 60 Hz, 40 watt with a power supply transistorized input DC 12 volt. Weight of the unit is 53 lbs. (24 kg).

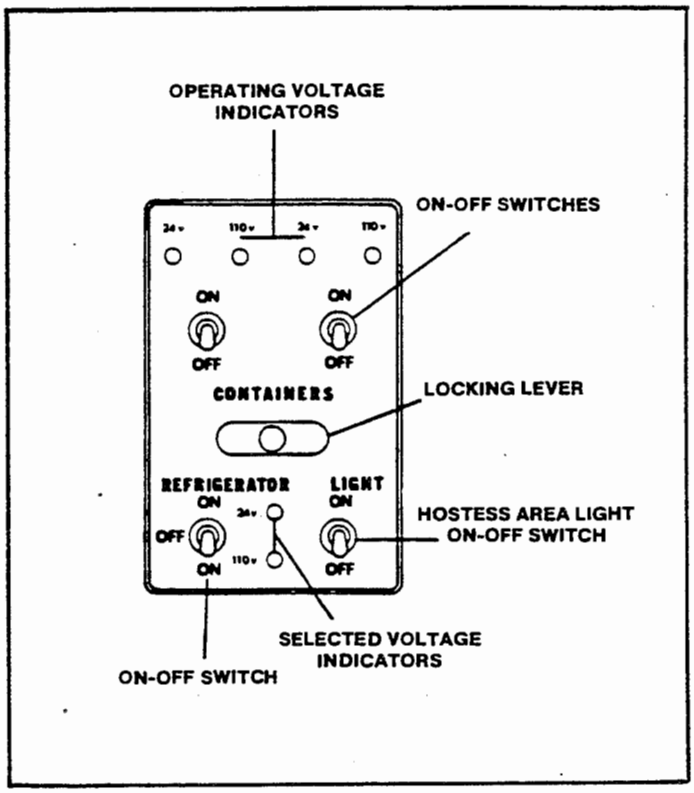


Figure 3-48. Mini Galley Control Panel.

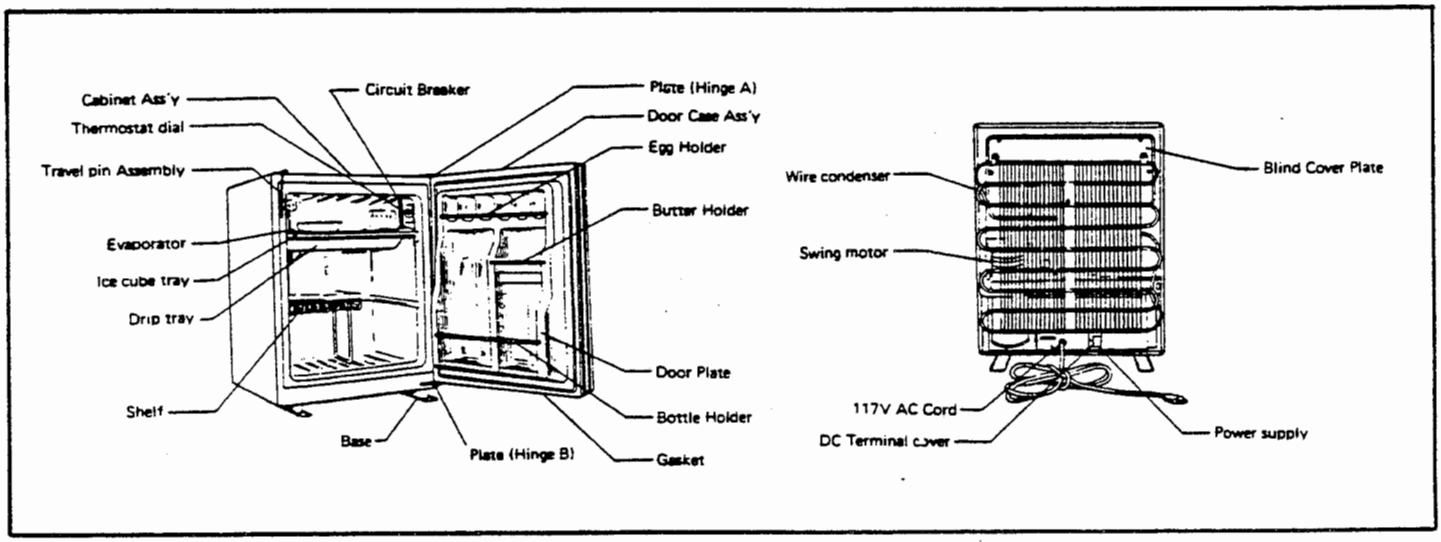


Figure 3-47. Norcold DE-250E.

MC-9 MAINTENANCE MANUAL

REPLACING COOLING UNIT

Disconnect all power sources and remove all food. Remove the three screws which secure the thermostat assembly to the cabinet. Remove the two nuts on the evaporator, lower the front and carefully pull it forward out of its holder.

Remove power supply couplers and ground wire, then remove the eight screws holding on the rear cover plate. Remove both flange nuts from the cooling unit and slowly pull outwards by holding onto the hanger. Ensure the evaporator does not catch on the inner case.

Remove both cords from the swing motor.

Allow the cooling unit to lay on the condenser side, remove the two screws from the blind cover and the capillary tube located at the bottom of the evaporator. Move the inner suction pipe inner bushing as indicated in figure 3-50 and remove.

For installation follow the reverse order of disassembly.

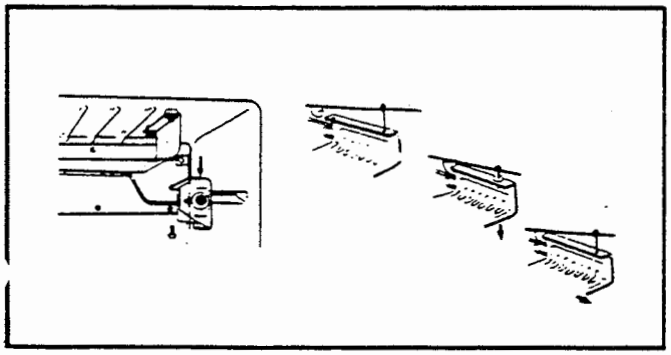


Figure 3-49. Removing Thermostat And Evaporator.

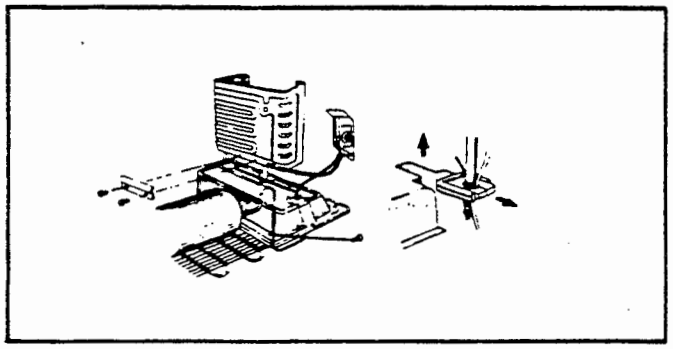


Figure 3-50. Removing Capillary Tube And Bushing.

REPLACING THERMOSTAT

Remove the three screws on the thermostat mounting and the two screws holding the capillary tube underneath the evaporator. Pull off the thermostat dial and detach the set plate from the thermostat support in the direction shown in figure 3-51.

Peel off the dial mark from the cover and remove the two screws holding the thermostat to its support. Detach the thermostat receptacle and disengage the two grey wires from the slip-on connectors. To replace the thermostat follow the reverse order of disassembly.

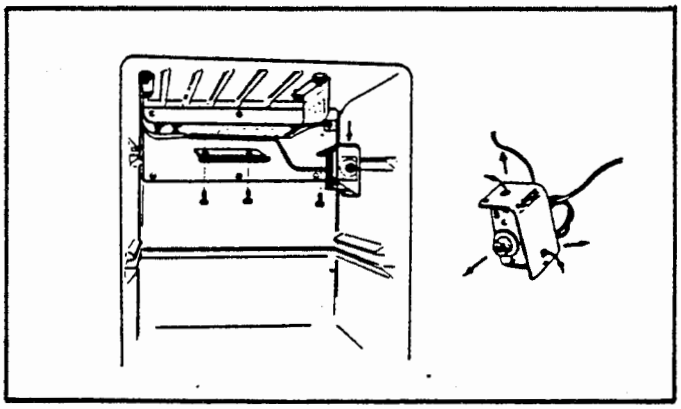


Figure 3-51. Removing Capillary Tube And Thermostat.

REPLACING THE POWER SUPPLY

Remove the seven screws securing the power supply to the rear of the cabinet. Remove the ground cord and disconnect the two power supply cords. Remove the transformer assembly from the power supply. Cut off the AC supply cord at its connecting point and release the grommet securing it to the case. Release the grommet securing the DC cord to the power supply case.

Remove all the screws securing the oscillator assembly and relay to the power supply case. Disconnect the 9-pole coupler connecting the oscillator assembly and the transformer assembly. Replace the transformer or oscillator following the reverse order of disassembly.

When replacing with new parts, ensure that wires are connected exactly as removed.

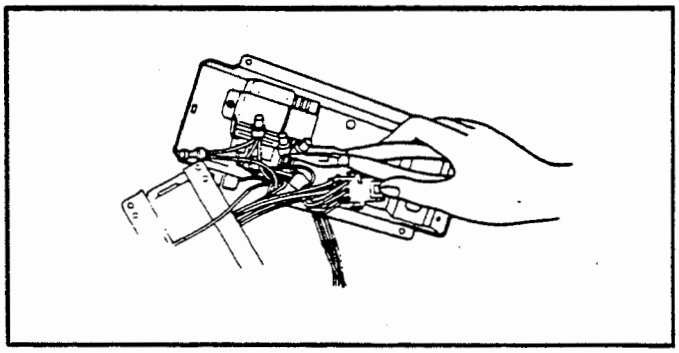


Figure 3-52. Cut Off AC Supply Cord.

MC-9 MAINTENANCE MANUAL

TROUBLESHOOTING

There are basic steps in troubleshooting the dual-voltage refrigerator that, if followed, make problem pinpointing a simple process. The three major component assemblies that will prevent operation are:

1. Compressor and System Assembly

This assembly consists of the swing motor compressor, condenser, dryer, capillary tube, and evaporator plate. After these components have been connected to form a closed loop or circulator system, this system is then charged with a measured amount of refrigerating gas Dichlorodifluoromethane R-12 and sealed to form a noncontaminated, closed system through which the gas is recycled over and over again during the refrigeration process.

Should a leak occur at any time in this system which allows this gas to escape, then the refrigeration capabilities of the system are terminated. A common symptom that the system has a leak is that the compressor runs continuously, but no cooling is obtained.

2. The Oscillator Transformer Assembly

This assembly consists of a dual-voltage transformer and a solid-state oscillator. The oscillator is in operation on DC only and its only function is to invert the 12-volt DC power supply to 110 volts AC. The dual-voltage transformer ensures that the correct AC voltage (20V AC) is supplied to the swing motor compressor.

3. The Thermostat

This item is an adjustable temperature cold control that senses the temperature within the refrigerator and maintains it at the desired setting. Should this control fail, it may produce two different reactions: (a) The refrigerator will not operate and the unit will begin defrosting, or (b) the unit will not cycle but will run continuously, with the result that refrigeration temperatures are extremely cold in some cases, causing foodstuffs such as milk, soft drinks, or other liquids to freeze.

Troubleshooting your refrigerator becomes much easier if the conditions of operation with relation to the malfunction are known. An inoperative unit, dependent upon what component has caused the malfunction, has certain symptoms that, if known, will facilitate repairs. These symptoms are:

1. **Insufficient Cooling (compressor does not run)**
   Gas leak or defective contacts at thermostat
   Short circuit in motor, blown fuse, broken power supply cord or faulty transformer connections
   Transformer burned out
   Incorrect voltage supply

2. **Insufficient Cooling (compressor runs)**
   Refrigerant leak
   System freeze-up, clogging or uneven distribution of compressor oil (shut off until cool, run for 5 minutes, shut off, run for 5 minutes, and repeat).
   Dirty condensor
   Insufficient cooling air to condensor

3. **Refrigerator Too Cold**
   Thermostat incorrectly set, points worn, shorted or grounded out
   Loose thermostat capillary tube

4. **Abnormal Loud Noise**
   Loose parts in machine compartment
   Compressor mounting springs touching

5. **Compressor Does Not Operate On Both AC And DC**
   Polarity reversed
   Weak battery
   Faulty thermostat
   Oscillator defective
   Faulty transformer

6. **Intermittent Running**
   Oscillator transistors shorted

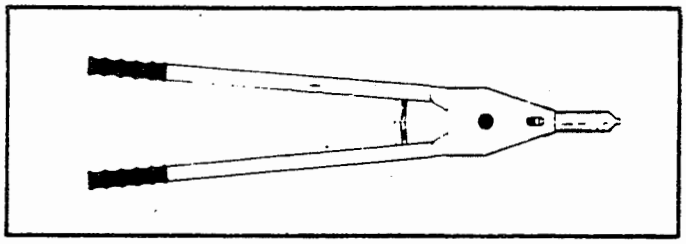
7. **Excess Frost Build-Up**
   Too much food stored blocking cooling air movement
   Defrost refrigerator

MC-9 MAINTENANCE MANUAL

SERVICE TOOLS

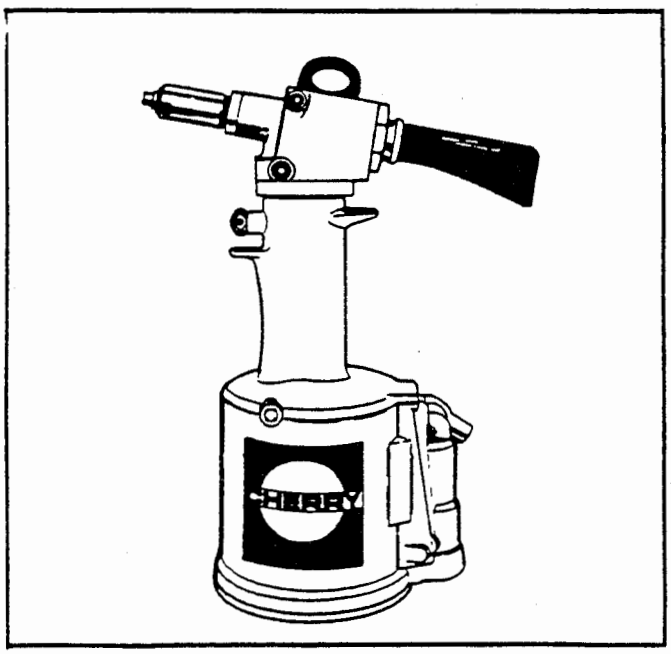
Some of the tools used for the maintenance procedures outlined in this section are nonstandard. They are, however, available for purchase from Motor Coach Industries, Transportation Manufacturing Corporation and Universal Coach Parts. Where practical, they may be fabricated by the service facility.

HAND RIVET GUN (AVDEL NO. 165)



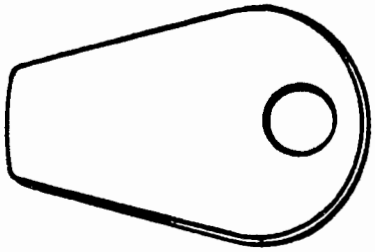
20-161 (C/W tip for ¼" Monobolt Rivets)

POWER RIVETER (GH743) 20-160



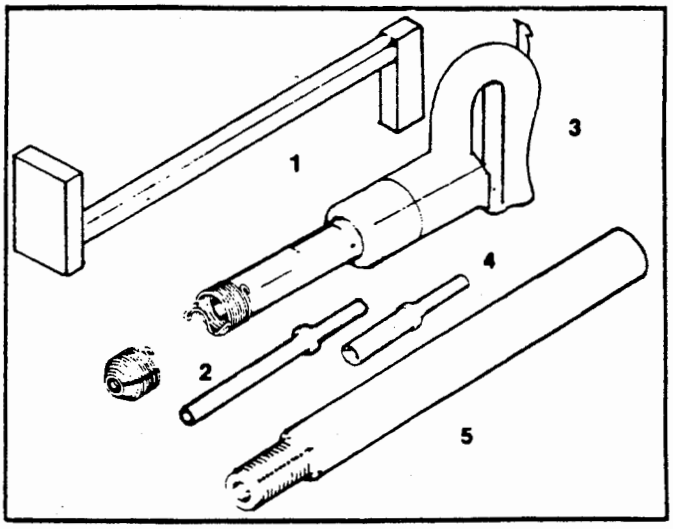
(also available, lighter duty No. GH703 not shown)

20-170 Nosepiece - ¼" Monobolt Rivet
20-160 Pulling Head - 3/16" Cherry "N" & Cherry "Q" Rivets
20-162 Pulling Head - 3/16" Cherry "C" Rivets



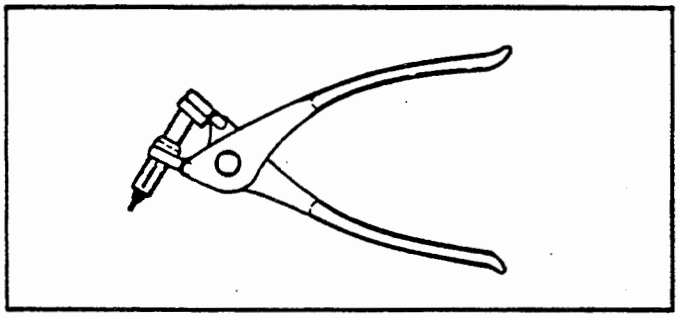
3J-15-150: Dzus Tool

Bucking or Squeezing



20-7: Buck Riveting Tool Kit - for brazier head, universal head, round head and flat head rivets of aluminum, steel or copper.
Consists of:
1. Rivet Bucking Foot.
2. 5/32" Brazier Head.
3. CP-4444 "A" Pneumatic Hammer Pistol Grip.
4. 7/32" Brazier Head.
5. Bucking Dolly Tool Holder.

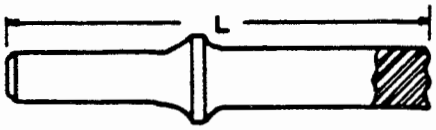
MC-9 MAINTENANCE MANUAL



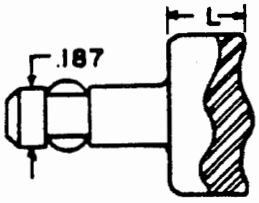
20-10: Panel Clamping Kit - Consists of:
1. Wedge Lock Clamp ¼" used to hold panels in place.
2. Wedge Lock Pliers for applying Clamp.

The following tools are required when replacing Stainless Steel Semi-Tubular Rivets.

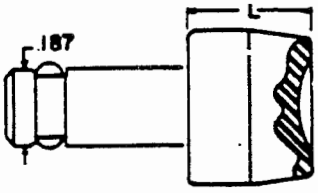
CP-4444A Pneumatic Hammer Pistol Grip



20-125: CP-4444A Rivet Gun Drive Set (3½" Long, 88.9 mm).
20-126: CP-444A Rivet Gun Tool Drive Set (5½" Long, 139.7 mm).



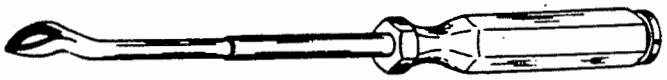
20-127: CP-444A Rivet Gun Flaring Squeezer Set (¼" Long, 6.35 mm).
20-128: CP-4444A Rivet Gun Flaring Squeezer Set (⅜" Long, 9.52 mm).



20-129: CP-4444A Rivet Gun Cupped Squeezer Set (¼" Long, 6.35 mm).
20-130: CP-4444A Rivet Gun Cupped Squeezer Set (⅜" Long, 9.52 mm).



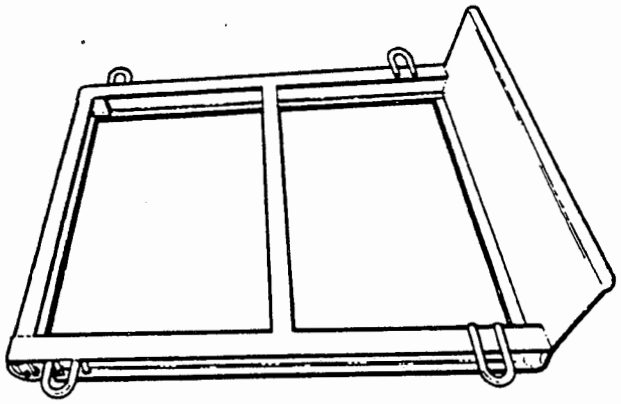
20-24 Entrance Door Linkage Wrench



NPN1703: Lacing Tool, 9/16" Eye



20-46 Tool — Cable Puller for Lift Type Baggage Doors



20-300 Lift and Tow Dolly

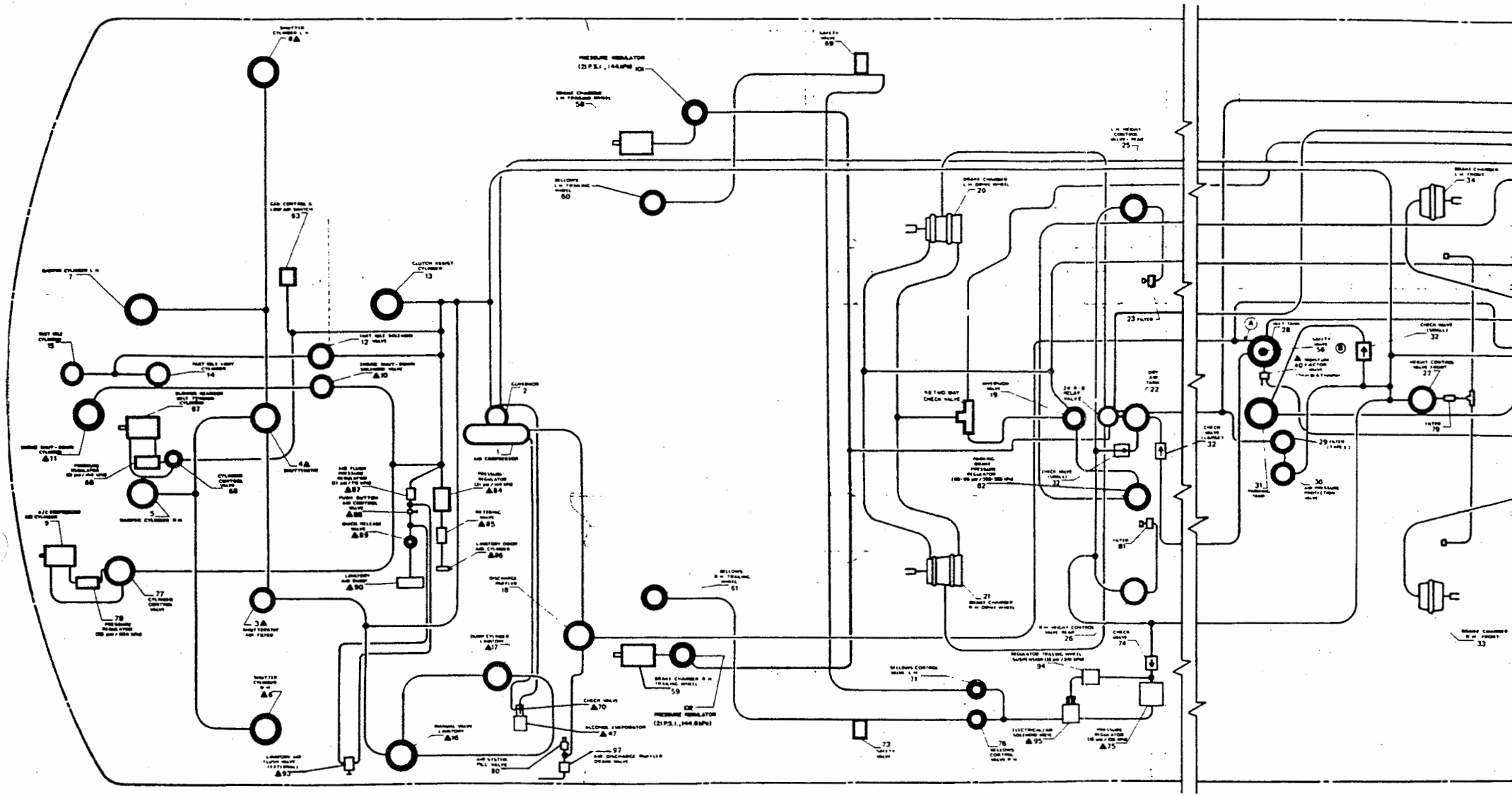
Date 1-1-89

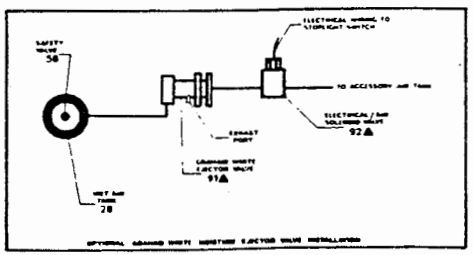
MC-9 MAINTENANCE MANUAL

SECTION 4

AIR SYSTEM AND BRAKES

SUBJECT	PAGE
Air Compressor	4-7
Air Dryer (AD-2)	4-35
Air Dryer (AD-4)	4-42
Air Horns and Valve	4-34
Air Line Check Valves	4-20
Air System	4-2
Brake Chambers	4-23
Brake Operation	4-2
Brakes	4-31
Dual Brake Application Valve	4-13
Governor	4-11
Inversion Valve	4-5
Low Air Pressure Switch and Alternator Control	4-20
Pressure Regulating Valves	4-22
Push-Pull Control Valve	4-4
Quick Release Valves	4-17
R-12 Rear Brake Relay Valve	4-18
Reservoirs	4-23
Safety Valve	4-19
Service Brake Stop Light Switch	4-21
Shuttle Valve	4-16
Slack Adjusters	4-28
Specifications	4-50
Troubleshooting Air System and Brakes	4-48
Service Bulletin Page	

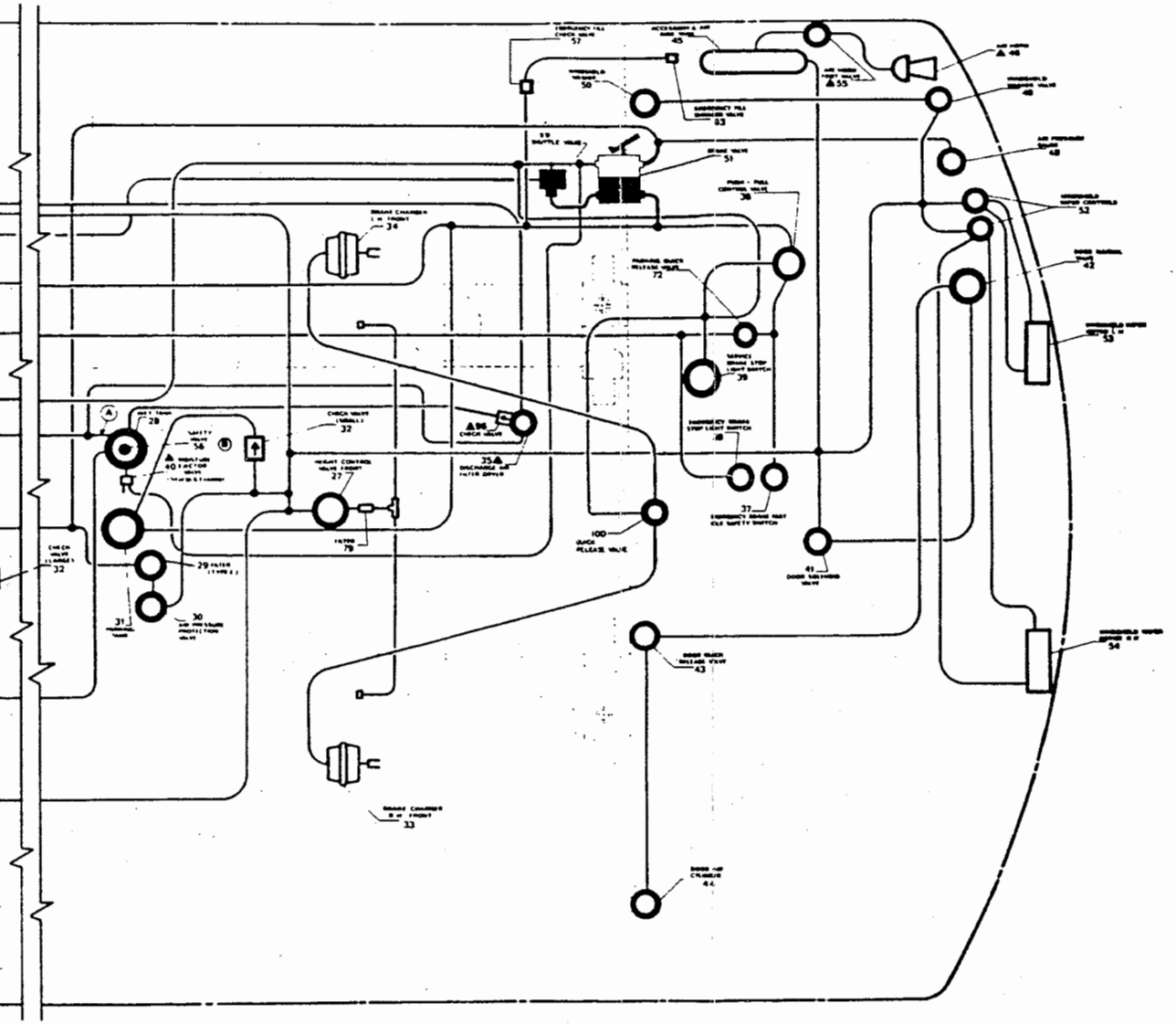



ELECTRICAL WIRING TO STOPLIGHT SWITCH
TO ACCESSORY AIR TANK
SAFETY VALVE 56
EXHAUST PORT
ELECTRICAL/AIR SOLENOID VALVE 92▲
GRAHAM WHITE EJECTOR VALVE 91▲
WET AIR TANK 28
OPTIONAL GRAHAM WHITE EJECTOR VALVE INSTALLATION

ITEM	DESCRIPTION	LOCATION
1	AIR COMPRESSOR	ENGINE COMPT.
2	GOVERNOR	ENGINE COMPT.
3 ▲	SHUTTERSTAT AIR FILTER	ENGINE COMPT.
4 ▲	SHUTTERSTAT	ENGINE COMPT.
5	DAMPER CYLINDER - R.H.	ENGINE COMPT.
6 ▲	SHUTTER CYLINDER - R.H.	BLOWER COMPT.
7	DAMPER CYLINDER - L.H.	ENGINE COMPT.
8 ▲	SHUTTER CYLINDER - L.H.	BLOWER COMPT.
9	A/C AIR CYLINDER	ENGINE COMPT.
10 ▲	ENGINE SHUT-DOWN SOLENOID VALVE	ENGINE COMPT.
11 ▲	ENGINE SHUT-DOWN CYLINDER	ENGINE COMPT.
12	FAST IDLE SOLENOID VALVE	ENGINE COMPT.
13	CLUTCH ASSIST CYLINDER	ENGINE COMPT.
14	FAST IDLE LIMIT CYLINDER	ENGINE COMPT.
15	FAST IDLE CYLINDER	ENGINE COMPT.
16 ▲	MANUAL VALVE - LAVATORY	ENGINE COMPT.
17 ▲	DUMP CYLINDER - LAVATORY	ENGINE COMPT.
18	DISCHARGE MUFFLER	ENGINE COMPT.
19	INVERSION VALVE	REAR WHEEL HSG.
20	BRAKE CHAMBER - L.H. DRIVE WHEEL	REAR WHEEL HSG.
21	BRAKE CHAMBER - R.H. DRIVE WHEEL	REAR WHEEL HSG.
22	DRY AIR TANK	REAR WHEEL HSG.
23	L.H. REAR SUSPENSION AIR FILTER	REAR WHEEL HSG.
24	R-B RELAY VALVE	REAR WHEEL HSG.
25	HEIGHT CONTROL VALVE - L.H. - REAR	REAR WHEEL HSG.
26	HEIGHT CONTROL VALVE - R.H. - REAR	REAR WHEEL HSG.
27	HEIGHT CONTROL VALVE - FRONT	FRONT WHEEL HSG.
28	WET AIR TANK	FRONT WHEEL HSG.
29	TYPE "E" FILTER	FRONT WHEEL HSG.

ITEM	DESCRIPTION	LOCATION
30	AIR PRESSURE PROTECTION VALVE	FRONT WHEEL HSG.
31	PARKING TANK	FRONT WHEEL HSG.
32	CHECK VALVE (LARGE & SMALL)	WHEEL HSGS.
33	BRAKE CHAMBER - R.H. - FRONT	FRONT WHEEL HSG.
34	BRAKE CHAMBER - L.H. - FRONT	FRONT WHEEL HSG.
35 ▲	DISCHARGE AIR FILTER DRYER	FRONT WHEEL HSG.
36	PUSH - PULL CONTROL VALVE	INTERIOR - FRONT
37	EMERGENCY BRAKE FAST IDLE SAFETY SWITCH	SPARE TIRE COMPT.
38	EMERGENCY BRAKE STOP LIGHT SWITCH	SPARE TIRE COMPT.
39	SERVICE BRAKE STOP LIGHT SWITCH	SPARE TIRE COMPT.
40 ▲	MOIST. EJECTOR VALVE (SEALCO & EXPELLO ONLY)	FRONT WHEEL HSG.
41	DOOR SOLENOID VALVE	SPARE TIRE COMPT.
42	DOOR MANUAL VALVE	DASH
43	DOOR QUICK RELEASE VALVE	SPARE TIRE COMPT.
44	DOOR AIR CYLINDER ENT. DOOR	INTERIOR - FRONT
45	ACCESSORY & AIR RIDE TANK	TOOL COMPT.
46 ▲	AIR HORN	ENGINE COMPT.
47 ▲	ALCOHOL EVAPORATOR	ENGINE COMPT.
48	AIR PRESSURE GAUGE	DASH
49	WINDSHIELD WASHER VALVE	DASH
50	WINDSHIELD WASHER	TOOL COMPT.
51	BRAKE VALVE	SPARE TIRE COMPT.
52	WINDSHIELD WIPER CONTROLS	DASH
53	WINDSHIELD WIPER MOTOR - L.H.	EXTERIOR - FRONT
54	WINDSHIELD WIPER MOTOR - R.H.	EXTERIOR - FRONT
55 ▲	AIR HORN FOOT VALVE	DRIVER'S FOOT REST
56	SAFETY VALVE (150 psi / 1030 kPa) (SEE NOTE 8)	FRONT WHEEL HSG.
57	EMERGENCY FILL CHECK VALVE	TOOL COMPT.
58	BRAKE CHAMBER - L.H. TRAILING WHEEL	REAR WHEEL HSG.

ITEM	DESCRIPTION	LOCATION
59	BRAKE CHAMBER - R.H. TRAILING WHEEL	REAR WHEEL HSG.
60	BELLOWS - L.H. TRAILING WHEEL	REAR WHEEL HSG.
61	BELLOWS - R.H. TRAILING WHEEL	REAR WHEEL HSG.
62		
63	GENERATOR CONTROL & LOW AIR SWITCH	ENGINE COMPT.
64		
65		
66	BLOWER BELT PRESSURE REGULATOR (21 psi / 144 kPa)	ENGINE COMPT.
67	BLOWER GEARBOX BELT TENSION CYLINDER	ENGINE COMPT.
68	CYLINDER CONTROL VALVE	ENGINE COMPT.
69	SAFETY VALVE (150-155 psi / 344-378 kPa) L.H. TRAIL WHL	ENGINE COMPT.
70 ▲	CHECK VALVE - ALCOHOL EVAPORATOR	ENGINE COMPT.
71	L.H. BELLOWS CONTROL VALVE	ENGINE COMPT.
72	PARKING QUICK RELEASE VALVE	SPARE TIRE COMPT.
73	SAFETY VALVE (150-155 psi / 344-378 kPa) R.H. TRAIL WHL	ENGINE COMPT.
74	CHECK VALVE - BELLOWS SUSPENSION	ENGINE COMPT.
75 ▲	TRAIL WH SUSP PRESS REG (10 psi / 103 kPa) (DUPLEX)	ENGINE COMPT.
76	R.H. BELLOWS CONTROL VALVE	ENGINE COMPT.
77	AC BELT TENSION CYLINDER CONTROL VALVE	ENGINE COMPT.
78	AC BELT TENSION PRESSURE REG. (95 psi / 654 kPa)	ENGINE COMPT.
79	FRONT SUSPENSION AIR FILTER	FRONT WHEEL HSG.
80	AIR SYSTEM FILL CHECK VALVE	ENGINE COMPT.
81	R.H. REAR SUSPENSION AIR FILTER	REAR WHEEL HSG.
82	PARKING BRAKE PRESSURE REG. (80-85 psi / 550-585 kPa)	REAR WHEEL HSG.
83	EMERGENCY FILL SCHRADER VALVE	TOOL COMPT.
84 ▲	LAV. DR. PRESSURE REGULATOR (21 psi / 144 kPa)	UNDER LAV. SINK
85 ▲	LAV. DOOR CYLINDER METERING VALVE	UNDER LAV. SINK
86 ▲	LAV. DOOR CYLINDER	LAVATORY COMPT.
87 ▲	AIR FLUSH PRESSURE REGULATOR (11 psi / 76 kPa)	UNDER LAV. SINK



ITEM	DESCRIPTION	LOCATION
59	BRAKE CHAMBER - R. H. TRAILING WHEEL	REAR WHEEL HSG.
60	BELLOWS - L. H. TRAILING WHEEL	REAR WHEEL HSG.
61	BELLOWS - R.H. TRAILING WHEEL	REAR WHEEL HSG.
62		
63	GENERATOR CONTROL & LOW AIR SWITCH	ENGINE COMPT.
64		
65		
66	BLOWER BELT PRESSURE REGULATOR (21 psi / 144 kPa)	ENGINE COMPT.
67	BLOWER GEARBOX BELT TENSION CYLINDER	ENGINE COMPT.
68	CYLINDER CONTROL VALVE	ENGINE COMPT.
69	SAFETY VALVE (90-95 psi / 344-378 kPa) L.H. TRAIL. WH.	ENGINE COMPT.
70 ▲	CHECK VALVE - AIR CONDITIONING EVAPORATOR	ENGINE COMPT.
71	L. H. BELLOWS CONTROL VALVE	ENGINE COMPT.
72	PARKING QUICK RELEASE VALVE	SPARE TIRE COMPT.
73	SAFETY VALVE (90-95 psi / 344-378 kPa) R.H. TRAIL. WH.	ENGINE COMPT.
74	CHECK VALVE - BELLOWS SUSPENSION	ENGINE COMPT.
75 ▲	TRAIL. WH. SUSP. PRESS. REG. (85 psi / 585 kPa) (UNLOAD)	ENGINE COMPT.
76	R. H. BELLOWS CONTROL VALVE	ENGINE COMPT.
77	AC BELT TENSION CYLINDER CONTROL VALVE	ENGINE COMPT.
78	AC BELT TENSION PRESSURE REG. (95 psi / 656 kPa)	ENGINE COMPT.
79	FRONT SUSPENSION AIR FILTER	FRONT WHEEL HSG.
80	AIR SYSTEM FILL CHECK VALVE	ENGINE COMPT.
81	R.H. REAR SUSPENSION AIR FILTER	REAR WHEEL HSG.
82	PARKING BRAKE PRESSURE REG. (80-85 psi / 550-585 kPa)	REAR WHEEL HSG.
83	EMERGENCY FILL SCHRADER VALVE	TOOL COMPT.
84 ▲	LAV., DR. PRESSURE REGULATOR (21 psi / 144 kPa)	UNDER LAV., SINK
85 ▲	LAV., DOOR CYLINDER METERING VALVE	UNDER LAV., SINK
86 ▲	LAV., DOOR CYLINDER	LAVATORY COMPT.
87 ▲	AIR FLUSH PRESSURE REGULATOR (11 psi / 76 kPa)	UNDER LAV., SINK

ITEM	DESCRIPTION	LOCATION
88 ▲	LAV., AIR FLUSH PUSH BUTTON AIR CONTROL VALVE	LAVATORY COMPT.
89 ▲	LAV., AIR FLUSH QUICK RELEASE VALVE	UNDER LAV. SINK
90 ▲	LAV., AIR FLUSH PUMP	ENGINE COMPT.
91 ▲	GRAHAM WHITE MOISTURE EJECTOR VALVE	FRONT WHEEL HSG.
92 ▲	ELECTRICAL / AIR SOLENOID VALVE	FRONT WHEEL HSG.
93 ▲	LAVATORY AIR FLUSH VALVE (EXTERNAL)	ENGINE COMPT.
94	REGULATOR TRAILING WH. SUSP. (35 psi / 241 kPa)	ENGINE COMPT.
95 ▲	ELECT / AIR SOLENOID VALVE (TR SUSP UNLOAD)	ENGINE COMPT.
96 ▲	CHECK VALVE AIR DRYER WHEEL HSG.	FRONT WHEEL HSG.
97	DRAIN VALVE - AIR DISCHARGE MUFFLER	ENGINE COMPT.
98	TWO WAY CHECK VALVE	REAR WHEEL HSG.
99	SHUTTLE VALVE	SPARE TIRE COMPT.
100	FIFTH BRAKE QUICK RELEASE VALVE	SPARE TIRE COMPT.
101	TRAIL WH. PRESS. REG. LH. (21 PSI / 144 kPa)	TRAIL WH. HSG.
102	TRAIL WH. PRESS. REG. R.H. (21 PSI / 144 kPa)	TRAIL WH. HSG.
▲	OPTIONAL EQUIPMENT	

(A) THIS LINE IS NOT INSTALLED IN COACHES HAVING OPTIONAL DISCHARGE AIR DRYER

(B) THIS SAFETY VALVE IS INSTALLED ON DISCHARGE AIR DRYER IN COACHES HAVING OPTIONAL DISCHARGE AIR DRYER.

MC-9 MAINTENANCE MANUAL

AIR SYSTEM AND BRAKES

AIR SYSTEM

The air system of the coach provides a means for braking, suspension, and for operating controls and accessories. This section covers brakes and air operated accessories. Details of the suspension system are covered in Section 12 of this manual. The air operating entrance door mechanism is covered in Section 3. The radiator shutter control system is covered under Section 6.

Included in this section is a schematic drawing of all air system components as well as a schematic drawing of the coach parking brake air system.

The basic air system consists of a compressor (which is mounted on and driven by the engine), air reservoirs, filters, and the necessary fittings and piping.

The brake system consists of brake chambers (one at each wheel), brake application valve, quick release valve, relay valve, parking brake (push-pull) valve, reservoirs, check valves and filters, and necessary fittings and connecting piping. See figure 4-1.

WARNING: To avoid personal injury when working on or around air systems and components, the following precautions should be observed:

1. Always block vehicle wheels. Stop engine when working under a vehicle. Venting vehicle air system pressure may cause vehicle to roll. Keep hands away from chamber push rods and slack adjusters; they may apply as system pressure drops.

2. Vent all air pressure from system.

3. Never connect or disconnect a hose or line containing air pressure. It may whip as air escapes. Never remove a component or pipe plug unless you are certain all system pressure has been vented.

4. Never exceed recommended air pressure and always wear safety glasses when working with air pressure. Never look into air jets or direct them toward anyone.

5. Never attempt to disassemble a component until you have read and understand recommended procedures. Some components contain powerful springs and injury can result if not properly disassembled. Use only proper tools and observe all precautions pertaining to use of those tools.

BRAKE OPERATION

The brakes used on the MC-9 coach incorporated both service and parking air operated brakes. Operation of the air operated parking brake is as follows. (Refer to figure 4-2 for schematic.)

NORMAL RUNNING - With the handle of the push-pull valve pushed in, air pressure from the parking and emergency reservoir is delivered to the control port of the inversion valve and then to the lock port of the rear brake actuator. Air pressure acting on piston A moves it forward and contacts rollers B rolling them up ramp A-A. As long as air pressure remains in lock port area, rollers B are not in contact with shaft F and normal service brake applications will permit shaft F to move freely.

PARKING - To park, the handle of the push-pull valve is pulled out. This vents the control port of the inversion valve and the lock port of the rear brake actuator. Spring D then forces rollers B against collar G thereby engaging rollers B with shaft F. When the control port of the inversion valve is vented, piston H moves forward to contact exhaust valve J. This action opens passage between parking and emergency reservoir port L and parking diaphragm port K. The valve then delivers 85 psi (586 kPa) regulated emergency reservoir pressure to the parking diaphragm of the actuator.

LOSS OF AIR PRESSURE WHILE PARKED - If there is a reduction of air pressure while parked, the force output of the diaphragm is reduced. The push rod force, however, is transferred to the mechanical lock mechanism to keep the brake applied. In this position rollers B are now wedged between collar G and shaft F preventing the return of shaft F to a released position. Shaft F is now locked in the applied position.

EMERGENCY OPERATION - If air pressure should be lost from the service reservoirs, the emergency brakes may be applied by pulling out the handle of the push-pull valve. Air from the emergency reservoir which is protected by a single check valve applies the brakes as described under parking.

If air is lost from the emergency reservoir and the wet service reservoir, a normal stop can be made with the service brakes because the dry service reservoir is protected by a single check. If pressure is lost from the emergency reservoir at a relatively slow rate, a partial parking application will be made when the handle of the push-pull valve trips automatically at about 40 psi (276 kPa). The inversion valve will likewise automatically trip at about the same pressure and apply the parking brakes even though the push-pull valve does not trip.

If pressure drops during operation, four parking brake applications can still be made. Parking and emergency brakes will not apply automatically until parking reservoir pressure drops below 40 psi (276 kPa).

MC-9 MAINTENANCE MANUAL

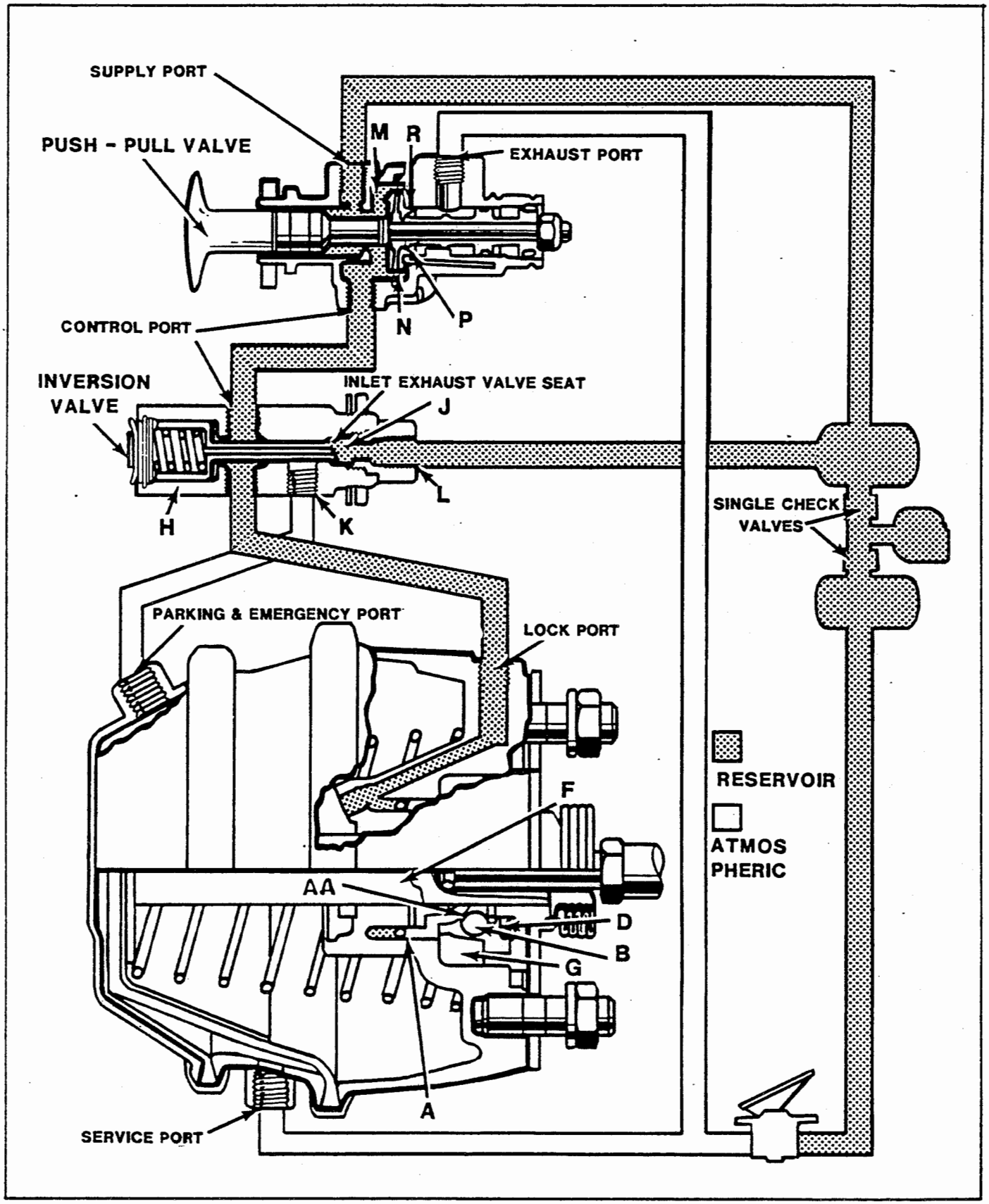


Figure 4-2. Parking Brake Schematic Diagram.

MC-9 MAINTENANCE MANUAL

WARNING: Air pressure gauge on the dash does not show parking brake reservoir pressure; it shows dry tank pressure. If pressure drops below 70-75 psi (483-517 kPa) during operation, LOW AIR tell-tale will flash and a warning buzzer will sound. The coach should be stopped immediately and the cause of the air loss corrected before proceeding. A sudden automatic parking brake application will result if low air pressure warning signals are ignored during operation.

RELEASE OF PARKING BRAKE

A. WHEN EMERGENCY PRESSURE HAS NOT DROPPED MORE THAN 4 psi (27.6 kPa). After applying the parking brake, push in handle of push-pull valve. This applies reservoir pressure to lock port of the actuator thereby releasing the locking mechanism. At the same time, air pressure is also admitted to the control port of the inversion valve which causes air to be exhausted from the parking diaphragm thereby releasing the brakes.

B. WHEN EMERGENCY PRESSURE HAS DROPPED MORE THAN 4 psi (27.6 kPa). After applying the parking brake, push in handle of push-pull valve. This applies reservoir pressure to the 'ocking port of the actuator which releases the locking mechanism. Reservoir pressure is simultaneously applied to the control port of the inversion valve which in turn causes air to be exhausted from the parking diaphragm. A heavy service brake application will then produce sufficient forward motion of the actuator piston rod to allow the locking mechanism to disengage. Releasing the service brake application will restore the system to normal running condition.

NOTE: If an inadvertent service brake application is made while the parking brakes are applied, the parking brakes will not release unless the handle of the push-pull valve is pushed in.

PUSH-PULL CONTROL VALVE

The push-pull control valve is used to control the flow of air to the parking ports of the rear brake chambers. It is mounted on the driver's console to the right of the driver's position. See figure 4-3.

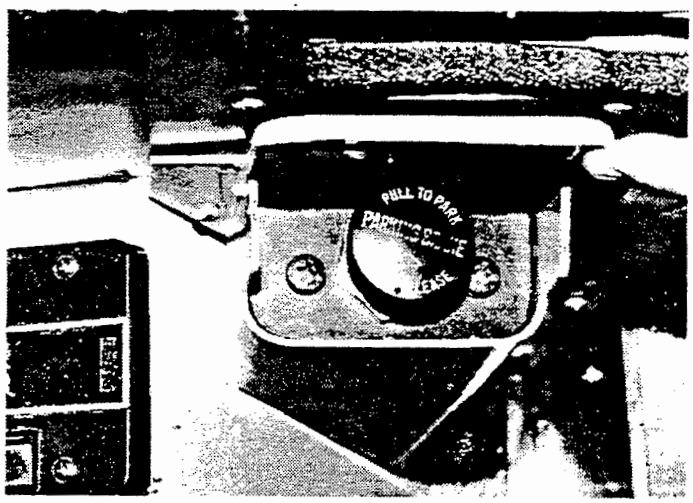


Figure 4-3. Push-Pull Control Valve.

In normal operation, the push-pull control valve knob is pushed down. To operate the parking and emergency brake, the plunger is pulled upward to the top position. The system then functions as outlined earlier in this section.

REMOVAL AND INSTALLATION

1. Block or hold vehicle by some means other than air brakes.
2. Vent air brake system. Disconnect the air lines from the control valve.
3. Drive out the spiral pin that holds the button on the control valve plunger. Remove button. (See figure 4-4.)
4. Remove the control valve mounting nut, then the control valve.

Before reinstalling, clean the air lines to the control valve and brake actuators. Installation is the reverse of removal.

1. Button
2. Spiral Pin
3. Nut
4. O-Ring
5. Body
6. Inlet & Exhaust Valve
7. Lockwasher
8. Machine Screw
9. O-Ring
10. O-Ring
11. Elastic Hex Nut
12. Bottom Cover
13. Piston
14. Sealing Ring
15. Spring
16. Plunger

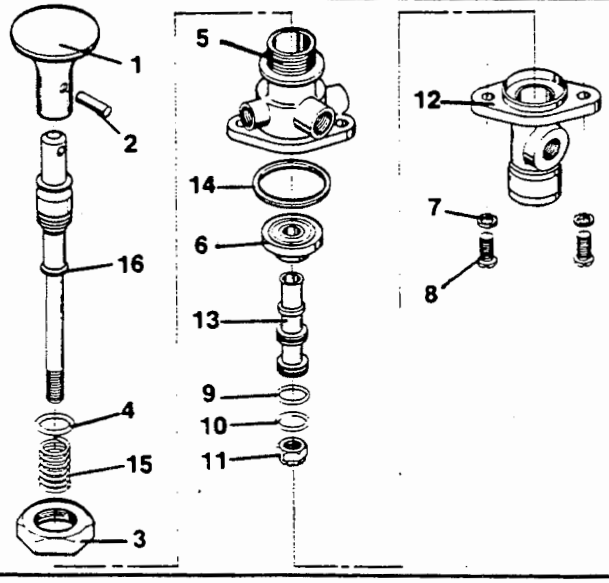


Figure 4-4. Push-Pull Control Valve Parts Breakdown.

DISASSEMBLY

WARNING: Pull rod bolt is under spring tension. To avoid possible injury, exercise care when removing pull rod bolt to slowly relieve spring tension.

1. Place the spring "cell" in a vise with pull rod bolt end up and the hex end of the rod held securely in the vise jaws. Slowly and cautiously remove the pull rod bolt. This will release the spring load as the bolt is removed.

2. Remove the springs. Remove the pull rod bolt from the piston.

3. Remove the seal grommet from the pull rod bolt. Remove cover from the pull rod.

4. Take pull rod out of vise.

NOTE: The spiral pin, button, and mounting nut are removed at the time the valve is removed from the vehicle dash. Insert a punch or rod in the plunger pin hole to keep the plunger from turning when removing the nut at the bottom of the valve.

5. Remove the plunger and spring. Remove plunger O-ring.

6. Remove the two cover screws and separate the cover from the body. Remove the cover seal O-ring and the inlet and exhaust valve.

7. Remove the piston, then the lower large piston O-ring, and then the upper piston O-ring.

REPAIR

1. Wash all metal parts in cleaning solvent and dry. Wipe reusable rubber parts clean.

2. Inspect all parts for excessive wear or deterioration.

3. Inspect the plunger and piston bores of the control valve for nicks and burrs. Check spring for cracks, distortion, or corrosion.

4. Inspect the inlet and exhaust valve and grommets for wear or deterioration.

5. Replace all parts not considered serviceable during these inspections, especially rubber parts.

REASSEMBLY

Prior to assembly, lubricate all O-rings and bearing surfaces of the body and cover with recommended lubricant, MCI/TMC Part No. 21-7512-11.

1. Install O-ring on plunger. Place spring on plunger.

2. Insert plunger, with spring and grommet installed, in body.

3. Install inlet and exhaust valve over protruding end of the plunger. The double beaded side of the inlet and exhaust valve should be up against the body seat.

4. Position cover to body seal in body. Attach the cover to the body with two screws.

5. Install the piston O-ring (large diameter O-ring in bottom piston groove). Install the piston with O-ring.

6. Depress the plunger, and with a punch or rod hold it from turning while installing the plunger stem nut. Torque on the stem nut should be between 30-40 inch pounds (3.3-4.5 Nm).

7. The control button should be installed and held in place by the spiral pin after the valve is mounted on the vehicle floor and held by the mounting nut.

INVERSION VALVE

When the control valve is operated, the inversion valve operates permitting air in the isolated reservoir to apply the brakes. The inversion valve also operates automatically when air pressure drops to a predetermined pressure.

With no system air pressure, the inversion valve inlet valve is open and its exhaust is closed. See figure 4-5. On initial build-up, as air enters the isolated reservoir to which the inversion valve supply port is connected, it will pass by the open inlet and out the delivery ports. When the system pressure reaches 50-60 psi (345-414 kPa) and the control valve is operated, air will pass into the inversion valve from the control valve. This air flows in one control port and exerts a force on the inversion valve piston. At a pressure between 60-70 psi (414-484 kPa), the piston moves against the resistance of the two piston springs. The piston exhaust seat moves away from the inlet and exhaust valve, opening the exhaust passage. The inlet valve spring and supply air at the inlet valve will cause it to seat. Air will then exhaust from the exhaust port.

The inversion valve is mounted on a bracket which is attached to the drive axle at the radius rod mounting bracket.

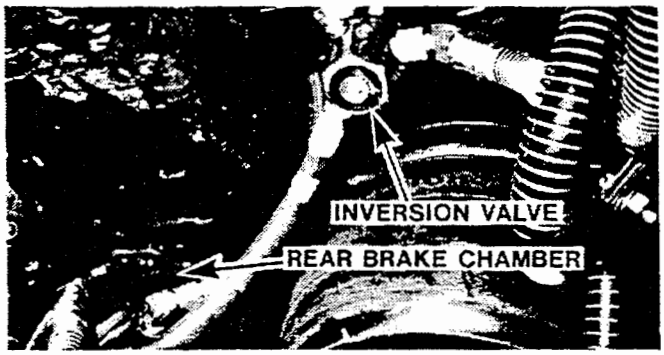


Figure 4-5. TR-2 Inversion Valve Installed

MC-9 MAINTENANCE MANUAL

MAINTENANCE

Every year or after 50,000 miles (80,000 km) the inversion valve should be disassembled, cleaned and lubricated. Rubber parts should be replaced and any other parts which show signs of wear or damage should also be replaced.

The air at the inversion valve control ports is exhausted through the control valve exhaust when it is operated. The piston springs will then cause the piston to move and seat on the inlet and exhaust valve closing the exhaust passage. The inlet valve is moved off its seat by the piston exhaust seat so supply air from the isolated reservoir will pass by the open inlet and out the delivery ports.

When the application is released by actuating the control valve, air passes into the inversion valve control port. The piston moves away from the inlet and exhaust valve, opening the exhaust passage through the piston. The inlet valve closes the air in the delivery ports exhausts through the center of the piston stem and out the inversion valve exhaust port.

REMOVAL AND INSTALLATION

1. Block and hold the vehicle by means other than air brakes.
2. Vent the service and isolated reservoir supplies. Disconnect all air lines from the inversion valve.
3. Loosen the valve mounting nut and remove the valve.

Prior to installation, check and clean the air lines to the valve. Mount the valve securely with mounting nut and lockwasher.

DISASSEMBLY

1. Refer to figure 4-6. Remove the cap nut with O-ring and remove the O-ring from the cap nut. Remove the inlet valve spring and inlet valve.
2. Turn the valve over and remove the exhaust check valve diaphragm screw, then diaphragm washer and diaphragm.
3. Remove the retaining ring. Remove the cover plate and two piston springs.
4. Remove the piston. Remove the piston O-rings.

REPAIR

1. Wash all metal parts in cleaning solvent and wipe clean. Inspect all parts for excessive wear or deterioration.
2. Check springs for cracks, corrosion, or distortion. Inspect the piston and its exhaust seat, body bores and inlet valve seat for nicks or burrs.
3. Replace all parts not considered serviceable.

REASSEMBLY

Before assembling the valve, lubricate the piston, O-rings and body bores.

1. Install the piston with O-rings in the valve body.
2. Position piston springs, cover plate and retainer ring in the piston in that order.
3. Press the cover and retainer down and snap the ring into the body groove.
4. Install the diaphragm and diaphragm washer and secure with the cap screw.
5. Turn the inversion valve over and position the inlet and exhaust valve in its bore. Place the spring down over the inlet valve.
6. Install the O-ring on the capnut. Install the capnut with the O-ring and tighten securely.
7. The mounting nut and lockwasher are installed when the valve is mounted on vehicle.

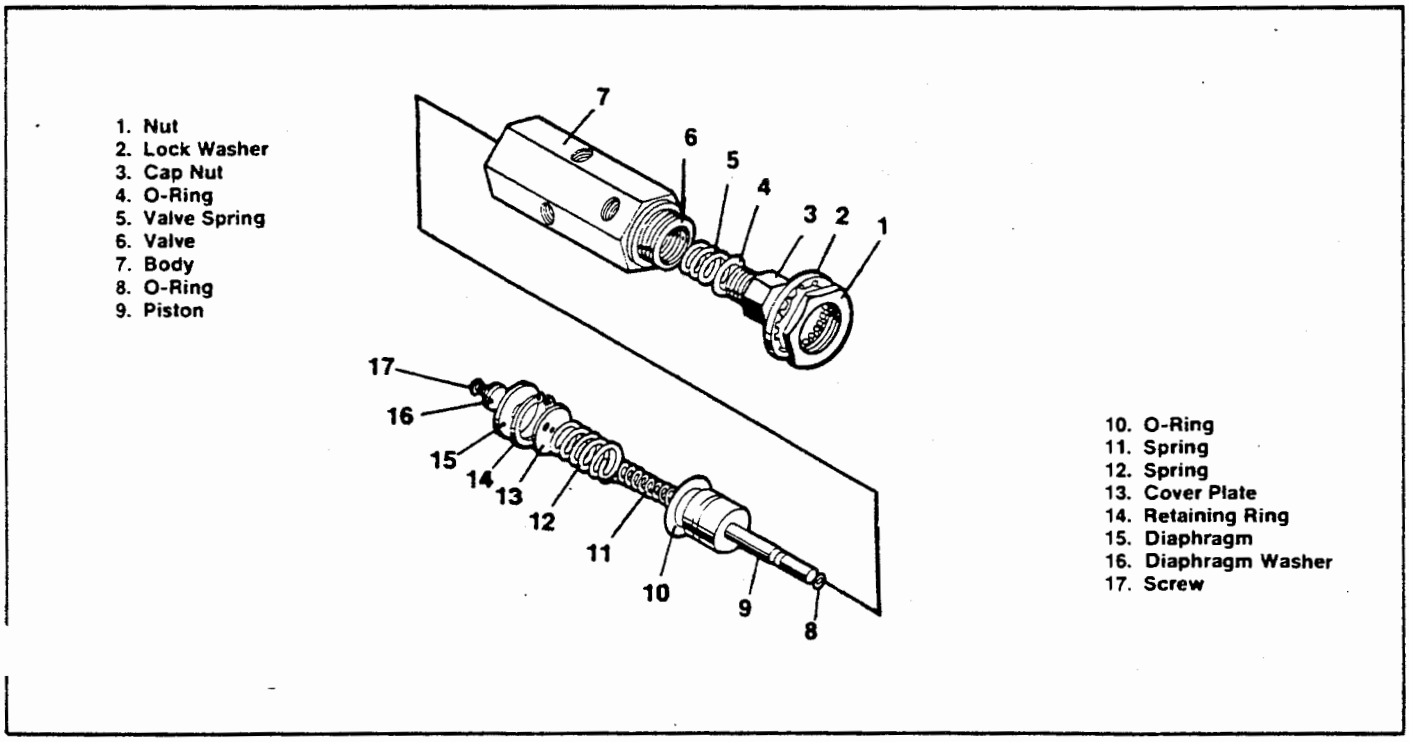


Figure 4-6. TR-2 Inversion Valve.

MC-9 MAINTENANCE MANUAL

AIR COMPRESSOR

OPERATION

The air compressor is to provide and maintain air under pressure to operate devices in the air brake and auxiliary air system. It is a two cylinder, single stage, reciprocating compressor with a rated displacement of 15.5 cubic feet (439 Cu Dm) air per minute at 1250 RPM.

The compressor assembly is made up of three cast iron subassemblies; the cylinder head, the cylinder block and the crankcase. The cylinder head houses the discharge valving and is installed to the cylinder block. The cylinder block houses the cylinder bores and inlet valves and is installed to the crankcase. The crankcase houses the crankshaft and main bearings.

The cylinder head and block coolant is routed to the compressor from the engine cooling system. Lubrication of the internal parts of the compressor is provided by the oil feed line from the engine's pressurized oil system.

The compressor runs continuously while the engine is operating but actual compression is controlled by the governor which stops or starts the compression of air by loading or unloading the compressor in conjunction with its unloading mechanism. This is done when the air pressure in the system reaches the desired maximum or minimum pressures.

A. INTAKE AND COMPRESSION (Loaded): During the downstroke of the piston, a slight vacuum created above the piston causes the inlet valve to move off its seat. Atmospheric air is drawn in through the compressor intake, past the open inlet valve, and on top of the piston. See figure 4-7. As the piston starts its upward stroke, the air is compressed. Now, air pressure on top of the inlet valve plus the force of its spring, returns the inlet valve to its seat. The piston continues the upward stroke and compresses the air sufficiently to overcome the discharge valve spring and unseat the discharge valve. The compressed air then flows past the open discharge valve, into the discharge line and on to the reservoirs. Refer to figure 4-8. Intake and compression cycle is repeated.

As the piston reaches the top of its stroke and starts down, the discharge valve spring returns the discharge valve to its seat. This prevents the compressed air in the discharge line from returning to the cylinder bore as the intake and compression cycle is repeated.

B. NON-COMPRESSION (Unloaded): When the air pressure in the reservoir reaches the high pressure setting of the governor, the governor opens, allowing air to pass from the reservoir through the governor and into the cavity beneath the unloader pistons. This lifts the unloader pistons and plungers. The plungers move up and hold the inlet valves off their seats.

C. INLET VALVES HELD OFF THEIR SEATS: Air is merely pumped back and forth between the two cylinders (figure 4-9). When air is used from the reservoir and the pressure drops to low pressure setting of the governor, the governor closes and in doing so exhausts the air from beneath the unloader pistons. The unloader saddle spring forces the saddle, pistons and plungers down and the inlet valves return to their seats. Compression is then resumed.

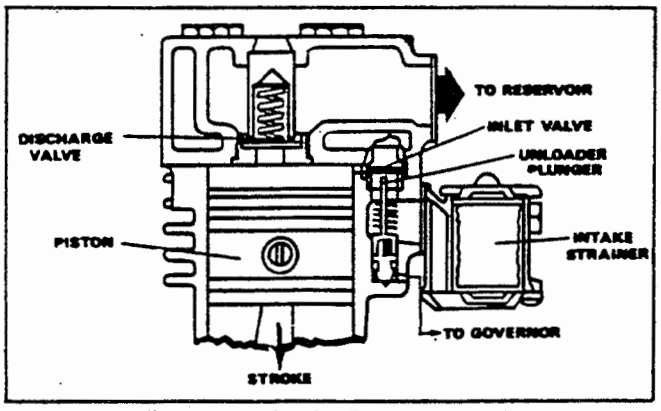


Figure 4-7. Intake Stroke Beginning.

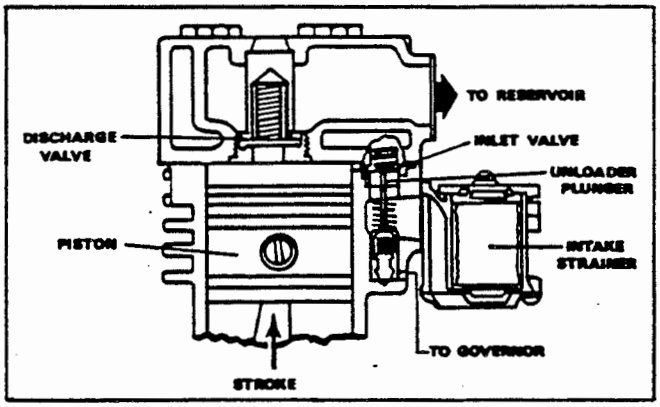


Figure 4-8. Compression Stroke Ending.

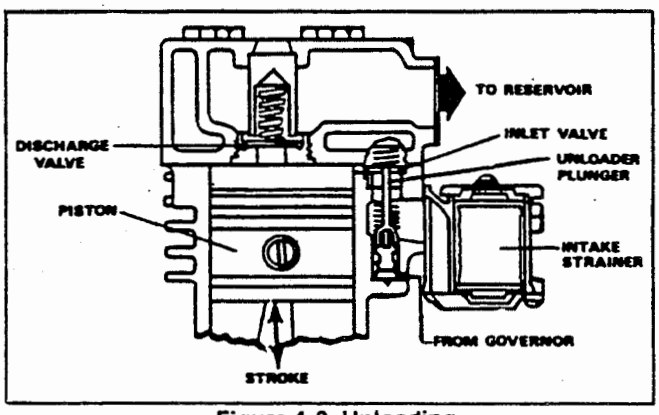


Figure 4-9. Unloading.

MAINTENANCE

Every 6 months, 1,800 operating hours or 50,000 miles (80,500 km), remove the discharge fittings and inspect the compressor discharge port and discharge line for excessive carbon deposits. If excessive build-up is noted in either, the discharge line must be cleaned or replaced and the compressor checked more thoroughly. Carefully inspect the air induction system, oil supply system and if necessary repair or replace compressor. Check for noisy compressor operation which could indicate a worn drive gear coupling. Check all compressor mounting bolts

and retighten evenly if necessary. Check for leakage and proper unloader operation.

Every 12 months, 3,000 operating hours or 100,000 miles (161,000 km) perform a thorough inspection; disassemble the compressor, clean and inspect all parts thoroughly, repair or replace all worn or damaged parts.

CAUTION: Should it be necessary to drain the engine cooling system to prevent damage from freezing, the cylinder head of the compressor must also be drained.

TROUBLESHOOTING

If the compressor fails to maintain adequate air pressure in the air system, it usually denotes loss of efficiency because of wear, provided leakage in the air system is not excessive. Oil passing is another sign of excessive wear.

Leakage past the discharge valves can be detected by removing the discharge line, applying shop air back through the discharge port and listening for escaping air. Also the discharge valves and unloader pistons can be checked for leakage by building up the air system until the governor cuts out, then stopping the engine.

With the engine stopped, carefully listen for escaping air at the intake. To pinpoint leakage if noted, squirt soapy water round the unloader pistons. If there is no noticeable leakage at the unloader pistons, the discharge valves may be leaking.

If the compressor does not function properly or leakage is excessive, it can be repaired as described below.

REMOVAL

1. Block all the wheels to prevent rolling and then vent the air brake system. Drain engine coolant as described in Section 6 and from compressor block.
2. Disconnect all air lines, water and oil lines to and from compressor.
3. Remove compressor mounting bolts and compressor from engine.
4. Use a gear-puller to remove the gear from compressor crankshaft.

DISASSEMBLY

1. Clean compressor exterior of dirt and grease using a cleaning solvent.
2. Before the compressor is completely disassembled the following items should be marked to show their relationship when the compressor is assembled: the cylinder block in relation to crankcase; end covers in relation to crankcase; position of crankshaft in relation to crankcase; the cylinder head's relation to the block. Refer to figure 4-10.
3. Remove capscrews and lift off cylinder head. It may have to be tapped with a rawhide hammer to break gasket joint.
4. Remove inlet valve springs from head and inlet valves from their guides in the block. Scrape off cylinder head gasket from cylinder head and block.
5. Remove discharge valve capnuts and lift out discharge valve springs and valves.

NOTE: The discharge valve seats can be removed, but it is not necessary unless they are badly worn or nicked.

ROD ASSEMBLIES:

6. Straighten prongs of connecting rod bolt lockwashers and remove bolts, lockwashers and bearing caps.
7. Push piston with connecting rods attached out the top of the cylinder block. Replace bearing caps on their respective connecting rods.
8. Remove piston rings from pistons.
9. To remove pistons from connecting rods, remove wrist pin lockwire and press wrist pins from pistons and connecting rods.

NOTE: If connecting rods are aluminum, do not re-use. Replace with new die cast aluminum rod assemblies. Steel connecting rods can be reused and re-bushed if necessary.

10. Remove capscrews securing end cover at drive end of crankshaft.

CRANKCASE:

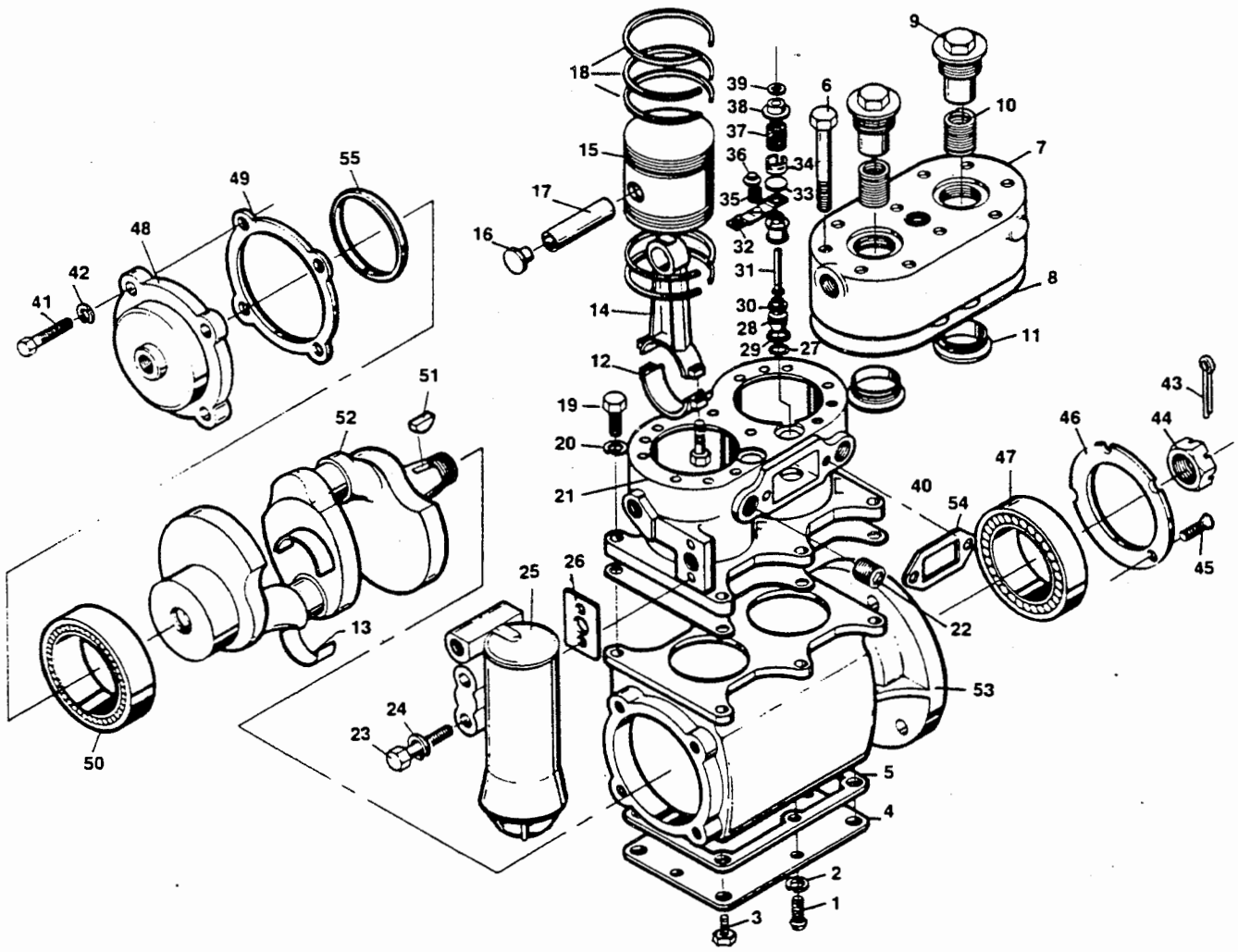
11. Remove end cover with oil seal; remove end cover gasket. Replace oil seal after cleaning end cover.
12. Remove capscrews that hold opposite end cover to crankcase; remove end cover and its gasket.
13. Press the crankshaft and ball bearings from the crankcase, then press ball bearings from crankshaft.

BLOCK:

14. If compressor is fitted with an air strainer, inlet elbow or governor, remove them.
15. Remove capscrews securing cylinder block to crankcase; separate crankcase and cylinder block and scrape off gasket.
16. Remove unloader spring, spring saddle and spring seat from cylinder block.
17. Remove unloader guides and plunger and with the use of shop air. Blow unloader pistons out of cylinder block unloader piston bores.
18. Remove inlet valve guides.

NOTE: Inlet valve seats can be removed but only if they are worn or damaged and are being replaced. Unloader bore bushings should be inspected but not removed unless they are damaged.

MC-9 MAINTENANCE MANUAL



1. Machine Screw
2. Lock Washer
3. Capscrew
4. Cover
5. Gasket
6. Capscrew
7. Cylinder Head
8. Gasket
9. Cap Nut
10. Valve Spring
11. Valve Seat
12. Connecting Rod Cap
13. Bearing
14. Connecting Rod
15. Piston
16. Button, Wrist Pin
17. Wrist Pin
18. Piston Ring
19. Capscrew
20. Lock Washer
21. Cylinder Block
22. Pipe Plug
23. Capscrew
24. Lock Washer
25. Governor Assembly
26. Gasket
27. O-ring
28. Piston, Unloader
29. Back-Up Ring
30. Plunger Guide
31. Plunger, Unloader
32. Saddle, Unloader Spring
33. Inlet Valve
34. Guide, Inlet Valve
35. Spring, Unloader
36. Seat, Unloader Spring
37. Spring, Inlet Valve
38. Insert, Spring
39. Seat, Inlet Valve Spring
40. Gasket
41. Capscrew
42. Lock Washer
43. Cotter Pin
44. Nut, Crankshaft
45. Machine Screw
46. Retainer, Bearing
47. Bearing
48. Cover
49. Gasket
50. Bearing
51. Key, Crankshaft
52. Crankshaft
53. Crankcase
54. Gasket
55. Seal

Figure 4-10. Air Compressor.

INSPECTION

1. Check fit of wrist pins on pistons and connecting rod bushings. Wrist pin should be a light press fit in pistons. If wrist pin is a loose fit, the pin, piston, or both should be replaced.

2. Check fit of wrist pin in connecting rod bushing by rocking the piston. This clearance should not exceed .0007" (.0178 mm). Replace wrist pin bushing if excess clearance is found. Wrist pin bushings should be reamed after being pressed into connecting rods. Replace used wrist pin lockwires.

3. Always replace die cast aluminum rods with new ones.

4. Check fit of piston rings in piston ring grooves. Check ring gap with rings installed in cylinder bores. Refer to figure 4-11 for correct gap and groove clearance.

5. Check crankshaft screw threads, keyways, tapered ends and all machined and ground surfaces for wear, scores, or damage. Crankshaft journals which are out of round more than .001" (.0254 mm) must be reground. Bearing inserts are available in .010" (.254 mm), .020" (.508 mm) and .030" (.762 mm) undersizes for reground crankshafts. Main bearing journals must be maintained so bearings are snug fit.

6. The oil seal ring groove or grooves in crankshafts fitted with oil rings must not be worn.

NOTE: The ring groove walls must have a good finish and they must be square. Check to be sure the oil passages are open and clean through the crankshaft.

7 Check connecting rod bearings on crankshaft journals for proper fit. Used bearing inserts should be replaced. Connecting rod caps are not interchangeable. The locking slots of the connecting rod and cap should be positioned adjacent to each other.

8. Check clearance between the connecting rod journal and the connecting rod bearing. It must not be less than .0003" (.0076 mm) or more than .0021" (.0533 mm) after rebuilding.

9. Check for wear or flat spots. If found, bearings should be replaced. If type with sleeve bearing, this bearing should be checked for scores and wear and replaced if necessary.

REPAIRS

DISCHARGE VALVES AND SEATS:

1. If discharge valve seats merely show signs of slight wear, they can be dressed by using a lapping stone, grinding compound and grinding tool. Install new discharge valves, valve springs, and cap nuts. The discharge valve travel should be between .030-.046" (.762-1.168 mm).

2. To test for leakage past the discharge valves, apply about 100 psi (690 kPa) air pressure through the cylinder head discharge port and apply soap suds at the discharge valves and seats. If excessive leakage is found, leave the air pressure applied, and with the use of a fiber or hardwood dowel and hammer, tap the discharge valves off their seats several times. This will help the valves to seat and should reduce any leakage.

3. With air pressure still applied at the discharge port of the cylinder head, check for leakage at the discharge valve capnuts. No leakage is permissible.

INLET VALVES AND SEATS:

4. If inlet valve seats show signs of slight nicks or scratches, they can be redressed with a fine piece of emery cloth or by lapping with a lapping stone, grinding compound and grinding tool. If the seats are damaged to the extent that they cannot be reclaimed, they should be replaced. The dimension from the top of the cylinder block to the inlet valve seat should not exceed .145" (3.683 mm) nor be less than .101" (2.565 mm). Slightly worn or scratched inlet valves can be reclaimed by lapping them on a piece of fine crocus cloth on a flat surface, but it is suggested that new inlet valves be installed.

REASSEMBLY

1. Position block gasket and block on crankcase according to markings made prior to disassembly. Using capscrews with lockwashers, secure cylinder block to crankcase.

2. If the crankshaft is fitted with oil seal rings, install rings. Position ball bearings and crankshaft in crankcase making sure the drive end of the crankshaft is positioned as marked before disassembly.

3. Carefully press crankshaft and bearings into crankcase using arbor press.

4. Position a new rear end cover gasket over the rear end of the crankcase making sure the oil hole in the gasket lines up with the oil hole in the crankcase.

5. Position end cover with oil seal ring installed over crankcase and end cover gasket. The end cover should be positioned correctly in relation to the oil holes in the gasket and crankcase. Secure the end cover to the crankcase with capscrews and lockwashers.

6. If the opposite end cover requires an oil seal (removed on disassembly), a new seal should be pressed into end cover. Position new end cover gasket and carefully install end cover over crankshaft and to crankcase avoiding damage to the seal. Secure end cover with capscrew and lockwashers. If connecting rods are steel, they can be reused and serviced as follows. Do not reuse aluminum die cast connecting rods.

7. If new wrist pin bushings are to be used, they should be pressed into the connecting rods so that the oil hole in the bushing lines up with the one in the rod. The new bushings should then be reamed or honed to provide between .0001" (.0025 mm) and .0006" (.0152 mm) clearance on the wrist pin.

8. Position connecting rod in piston and press in wrist pin so that lockwire hole in the pin aligns with that in the piston.

9. Install new lockwire through piston and wrist pin and lock it by snapping short end into lockwire hole at the bottom of the piston.

10. Install piston rings in correct location with ring pipmarks up. Stagger the position of the ring gaps.

11. Coat piston, piston rings, wrist pin and connecting rod bearings with clean engine oil before installing them in the compressor.

12. Remove connecting rod bolts and bearing cap from one connecting rod.

CAUTION: It is important that caps and rods are not intermixed.

13. Turn crankshaft so one of its connecting rod journals is in the downward, center position. Insert the connecting rod with piston through the top of the cylinder whose journal is down.

14. Position and attach the bearing cap to the connecting rod making sure the bolt and lockwashers are properly positioned on the cap. Tighten connecting rod bolts evenly and bend the two new lockwasher prongs up against the hex head of the bolt.

MC-9 MAINTENANCE MANUAL

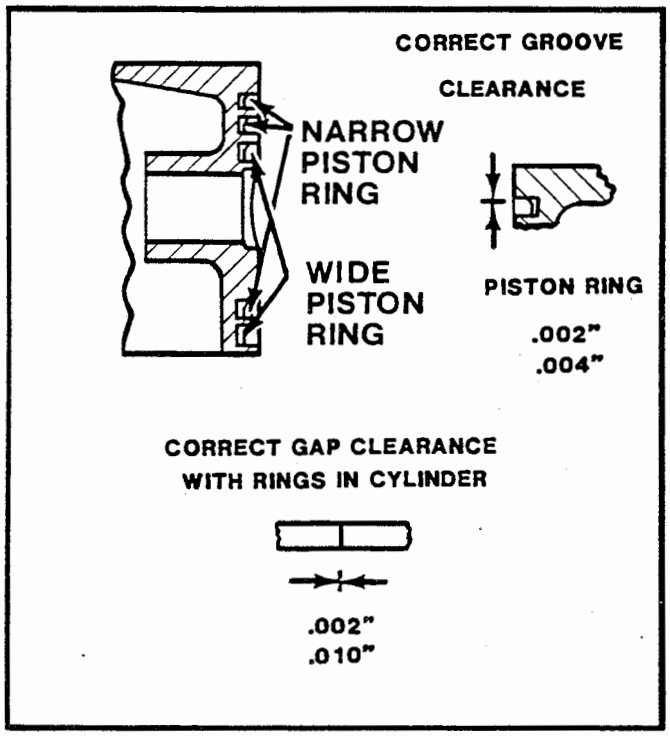


Figure 4-11. Piston Fits and Tolerances.

15. Install the other connecting rod and piston in the same manner.

16. Coat unloader pistons and their bores with special lubricant (dimethyl polysiloxane) prior to installation. If new unloader kits are being installed, the pistons in the kit are already lubricated.

17. Install the unloader pistons in their bores with caution against cutting the O-rings or distorting the back-up rings.

18. Position unloader plungers in their guides and slip them in and over the tops of the pistons.

19. Install the unloader spring seat in the cylinder block; a small hole is drilled in the block for this purpose.

20. Position the saddle between unloader piston guides so its forks are centered on the guides. Install the unloader spring making sure it seats over the spring seats both in the block and on the saddle. (See figure 4-12.)

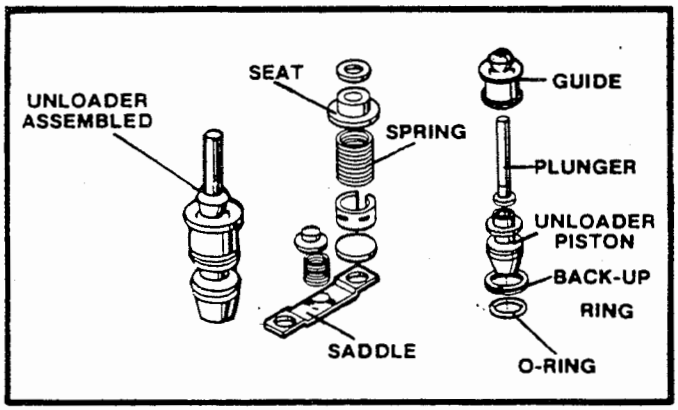


Figure 4-12. Unloader Mechanism.

21. Install inlet valve seats if they have been previously removed. Position and install inlet valve guides, then drop inlet valves in their guides. There should be a loose sliding fit between guides and valves.

22. If previously removed, the discharge valve seats should be installed. Drop discharge valves into their seats. Install discharge valve springs and cap nuts.

23. Place the inlet valve springs in the cylinder head. Use a small quantity of grease to hold them in place, just enough grease to keep the springs from falling out.

24. Place cylinder head gasket on cylinder block. Carefully align cylinder head assembly on block and install capscrews with lockwashers.

INSTALLATION

1. Before installation, clean oil supply line. Before connecting this line to the compressor run the engine briefly to be sure oil is flowing freely through the supply line.

2. Clean the oil return line passages through the brackets; these passages must be unrestricted so oil can return to the engine.

3. Coat compressor cylinder walls and bearings with clean engine oil before assembling compressor.

4. Always use a new mounting gasket and be sure oil hole in gasket and compressor is properly aligned with oil return port.

5. Inspect drive coupling and associated parts for wear or damage. They must be tightly fitted on compressor crankshaft. Replace drive coupling if worn or damaged.

6. Install drive coupling on compressor crankshaft making sure it properly contacts the shaft and does not ride the key. Tighten crankshaft nut securely and install cotter pin.

7. Be sure the air cleaner is clean and properly installed. Compressor intake connections must be tight with no leakage.

8. Clean or replace any damaged, or dirty air or water lines which may be corroded, before connecting them to the compressor. Use a new discharge flange fitting gasket.

9. Tighten mounting bolts securely and evenly. After installation, run compressor and check for air, oil, or water leaks at compressor connections. Also check for noisy operation.

GOVERNOR

The governor, operating in conjunction with the compressor unloading mechanism, automatically controls the air pressure in the air brake or air supply system between the desired, predetermined maximum and minimum pressures. The compressor operates continually while the engine runs, but the actual compression of air is controlled by the governor which stops or starts compression. The governor has a piston upon which air pressure acts to overcome the pressure setting spring and controls the inlet and exhaust valve to either admit or exhaust air to or from the compressor unloading mechanism.

OPERATION

Reservoir air pressure enters the D-2 governor at its reservoir port and acts on the area of the piston and beneath the inlet and exhaust valve. As the air pressure builds up, the piston moves against the resistance of the pressure setting spring. The piston and inlet and exhaust valve move up when the reservoir air pressure reaches the cut-out setting of the governor. The exhaust stem seats on the inlet and exhaust valve and then the

inlet passage opens. Reservoir air pressure then flows past the open inlet valve, through the passage in the piston and out the unloader port to the compressor unloading mechanism. The air, besides flowing to the compressor unloading mechanism, also flows around the piston and acts on the additional area of the piston, assures a positive action and fully opens the inlet valve.

As the system reservoir air pressure drops to the cut-in setting of the governor, the force exerted by the air pressure on the piston will be reduced so that the pressure setting spring will move the piston down. The inlet valve will close and the exhaust will open. With the exhaust open, the air in the unloader line will escape back through the piston through the exhaust stem and out the exhaust port.

MAINTENANCE

After 15,000 miles (24,000 km), clean or replace governor filters. If cleaning, use a solvent which is known to have no detrimental effect on metal or rubber material. If filters are removed they should be replaced with new filters.

After 100,000 miles (161,000 km), disassemble the governor and clean and inspect all parts. Refer to figure 4-13.

SERVICE CHECKS

1. Start the engine and build up pressure in the air system and check the pressure registered by the dash gauge or test gauge at the time the governor cuts out, stopping the compression of air. The cut-out pressure should be approximately 115-118 psi (793-814 kPa) maximum.

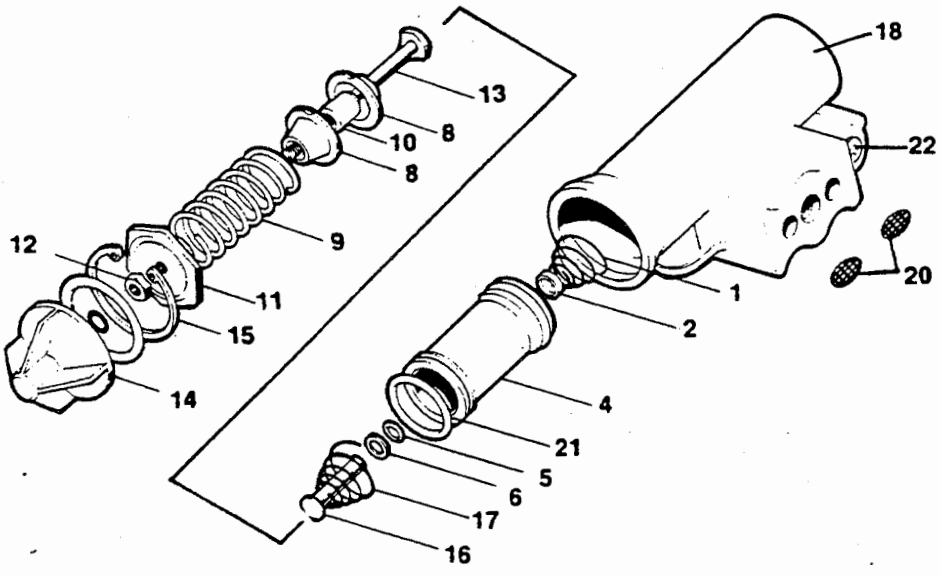
2. With the engine still running, make a series of brake applications to reduce the air pressure and observe at what pressure the governor cuts in the compressor. Cut-in pressure should be 95-105 psi (655-724 kPa).

NOTE: Never doubt or adjust the governor pressure settings unless they are checked with an accurate test gauge or a dash guage that is registering accurately.

3. If the pressure settings of the governor are inaccurate or it is necessary that they be changed, unscrew the cover at the top of the governor and loosen the adjusting screw locknut.

4. With a screwdriver, the adjusting screw is turned counterclockwise to raise the pressure settings, and turned clockwise to lower the pressure setting.

5. After the adjustment is completed, the adjusting screw locknut should be tightened to lock the setting.



1. Valve Spring
2. Valve
4. Piston
5. O-ring
6. Washer
8. Lower Spring Seat
9. Spring
10. Spring Guide
11. Upper Spring Seat
12. Nut
13. Adjusting Screw
14. Cover
15. Retaining Ring
16. Exhaust Stem
17. Exhaust Stem Spring
18. Body
20. Filter
21. O-ring
22. Pipe Plug

Figure 4-13. Governor Parts Breakdown.

LEAKAGE TEST

Leakage checks on the governor are made at its exhaust port in both cut-in and cut-out positions.

1. In the cut-in position, check exhaust port for inlet valve leakage by applying a soap solution at the port. Leakage could also be past the bottom piston O-ring.

2. In the cut-out position check the exhaust port to determine leakage at the exhaust valve seat or stem O-ring. In this position leakage could also be past the upper piston grommet.

REMOVAL AND INSTALLATION

1. Applying parking brake.
2. Drain air brake system and disconnect reservoir air line.
3. Remove governor mounting bolts, then governor.
4. Clean mounting pad on both compressor and governor block. Clean connecting line, or lines. Also be sure compressor unloading port is clear and clean.
5. Install governor using a new governor mounting gasket. Connect air lines to governor. Test governor as outlined in Service Checks.

DISASSEMBLY

1. Clean governor exterior of road dirt and grease using a good cleaning solvent and brush.
2. Unscrew the top cover. With a pair of retaining ring pliers, remove the spring assembly retaining ring.
3. Remove the adjusting screw and spring assembly. Remove the locknut, then the hex-shaped upper spring seat from the adjusting screw.
4. Remove the pressure setting spring, lower spring seat, spring guide and the other lower spring seat from the adjusting screw.
5. Remove the exhaust stem and its spring from the top of the piston.
6. With the body in the inverted position, tap it lightly and the piston should fall out.
7. Remove the inlet and exhaust valve springs and the valve from the piston.
8. Remove the two piston O-rings and with a hooked wire remove the exhaust stem O-ring.
9. Clean or remove the unloader and reservoir port filters.

CLEANING AND INSPECTION

1. Clean all metal parts with cleaning solvent. Wipe rubber parts dry.
2. Inspect body for cracks or other damage. Be particularly careful that all passages in the body, filters, exhaust stem, and the piston are not obstructed.
3. Check springs for cracks, distortion or corrosion. Replace all parts not considered serviceable during these inspections.

REASSEMBLY

Prior to reassembly lubricate the lower body bore, the top of the piston, the piston grooves, piston grommets, piston setting spring guide and the adjustable screw with recommended lubricant, MCI Part No. 4A-15-113.

1. Install the exhaust stem O-ring in its groove in the stem bore of the piston. Drop the inlet and exhaust valves into place at the bottom of the piston.
2. Install the inlet valve spring with its narrow end against the valve. Press the spring down until the large coiled end snaps into the groove inside the piston.
3. Position the exhaust stem spring over the exhaust stem, then carefully press the stem into the stem bore of the piston.
4. Install the piston in the body.
5. Install one lower spring seat, spring guide, the other lower spring seat, pressure setting spring, and the hex-shaped upper spring seat on the adjusting screw, in that order. Screw the upper spring seat down until the dimension from the top of the seat to the bottom of the stem head is approximately 1.142" (29.006 mm).
6. Install the locknut. Before placing the adjusting screw and stem assembly in the governor body, check to be sure the exhaust stem and its spring are in place in the piston.
7. Install the adjusting screw and spring assembly retaining ring. At this point, make the adjustment as outlies under Service Checks.
8. After the adjustment is made, the top cover should be screwed on tightly until it seals the body against the entrance of any foreign matter.
9. If necessary, install new filters in the reservoir and unloader ports. These cup-shaped filters can be installed with the head of a pencil.

DUAL BRAKE APPLICATION VALVE

DESCRIPTION

The brake valve is the control unit of the air brake system. See figure 4-14. It provides the driver with an easily operated and graduated means of applying or releasing the vehicle brakes. The brake valve is operated through a lever with a linkage connection to the brake pedal.

The dual brake valve has two separate supply and delivery circuits for service and emergency braking. The service brake portion is that section of the valve between the spring seat which contacts the plunger and the relay piston; the emergency brake portion is that part between the relay piston and the exhaust cavity.

The service brake portion of the valve is similar in operation to a standard single-circuit air brake valve, and under all operating conditions the emergency brake portion of the dual brake valve uses a common exhaust protected by an exhaust diaphragm.

MAINTENANCE

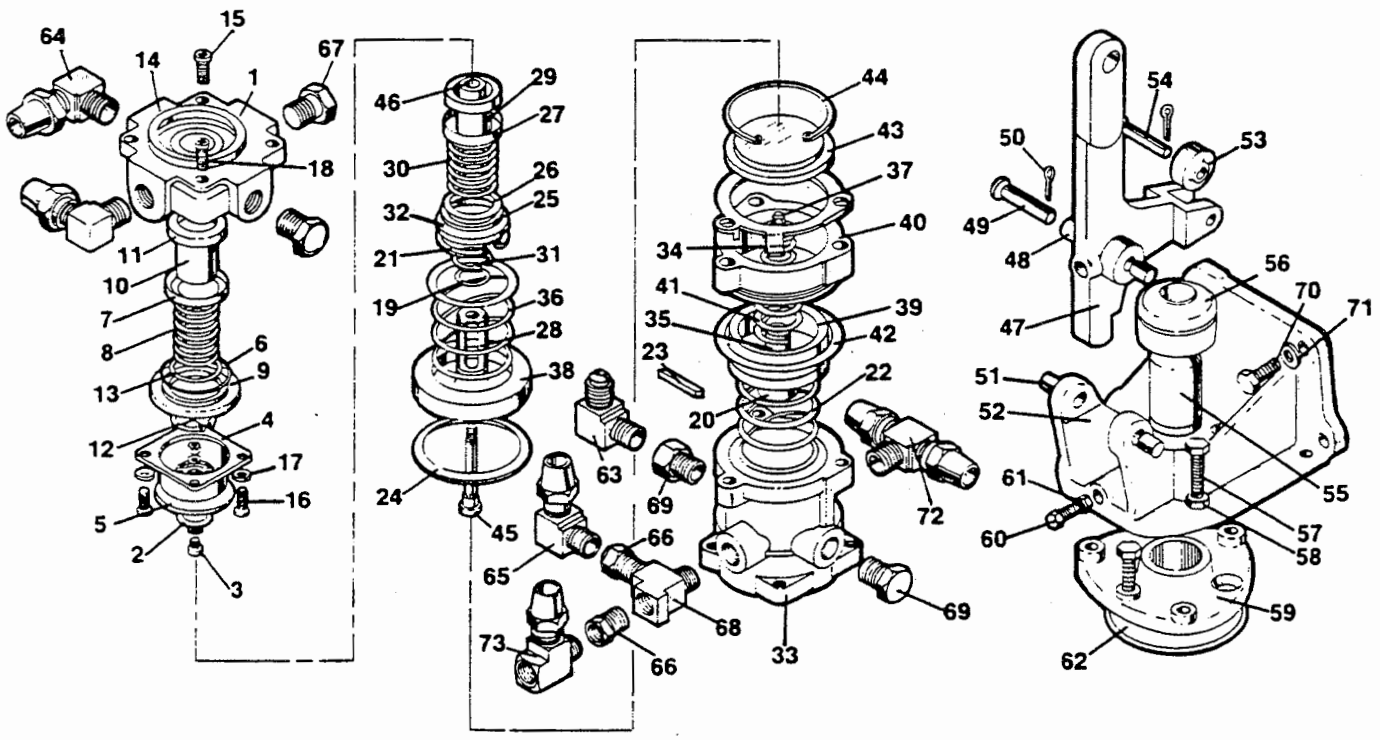
Every 300 operating hours, 20,000 miles (32,000 km) or every three months, clean any accumulated dirt, gravel or foreign material away from the heel of the treadle, plunger boot and mounting plate. Check the plunger boot for cracks, holes or deterioration and replace if necessary.

With the lever type brake valve, check to be sure that, with brakes fully applied, the pedal contacts the pedal stop. With brakes released, check to be sure that the lever arm contacts the stop button on the brake valve. Adjust pedal linkage to provide for this. After any adjustment, check the brake valve delivery pressure.

Lubricate the plunger using a silicone base lubricant TMC/MCI Part No. 21-7512-11.

Every 3,600 operating hours or 100,000 miles (161,000 km)

MC-9 MAINTENANCE MANUAL



1. O-ring
2. Washer, Diaphragm
3. Screw
4. Cover, Exhaust
5. Diaphragm, Exhaust
6. O-ring
7. Retainer, Valve
8. Spring, Valve
9. Retainer, O-ring
10. Valve, Inlet & Exhaust
11. Body
12. Retaining Ring
13. O-ring
14. Body, Lower
15. Screw, Machine
16. Screw, Machine
17. Lock Washer
18. Capscrew
19. O-ring
20. O-ring
21. Retaining Ring
22. Spring, Piston Return
23. Filter, Vent
24. O-ring
25. O-ring
26. O-ring
27. Retainer, Valve
28. Valve, Inlet & Exhaust
29. Body
30. Spring
31. Retaining Ring
32. Retainer, O-ring
33. Body, Upper
34. Guide, Spring
35. Guide, Spring
36. Spring, Piston
37. Lock Nut
38. Piston, Relay
39. Piston, Primary
40. Adapter
41. Spring, Grod.
42. O-ring
43. Retainer, Spring
44. Retaining Ring
45. Stem
46. Washer
47. Liner
48. Bushing
49. Pin
50. Cotter Pin
51. Bushing
52. Mounting Bracket
53. Roller
54. Pin
55. Plunger
56. Boot
57. Capscrew
58. Lock Washer
59. Adapter Plate
60. Screw, Adjusting
61. Lock Nut
62. Gasket
63. Elbow
64. Elbow
65. Elbow
66. Bushing, Reducer
67. Plug
68. Tee, Street
69. Adapter
70. Capscrew
71. Washer
72. Tee
73. Tee, Street

Figure 4-14. E-10 Brake Valve.

or yearly, the inlet and exhaust valves, exhaust diaphragm, O-rings and rubber graduating spring should be replaced if they show signs of wear or deterioration.

Every 7,200 operating hours or 200,000 miles (320,000 km) or every two years, disassemble the brake valve, clean and inspect all parts. Install new parts where they are found to be worn or damaged.

SERVICE CHECK

Check the service and emergency circuits using test gauges known to be accurate. Depress the pedal to several positions between the fully released and fully applied positions and check the delivered pressure on the test gauge to see that it varies equally and proportionately with the movement of the brake pedal.

After a full application is released, the reading on the test gauge should promptly fall off to zero. Service brake delivery pressure will be about 2 psi (13.8 kPa) greater than the emergency brake delivery pressure with both supply reservoirs at the same pressure. This is a normal condition.

WARNING: A change in vehicle braking characteristics or a low pressure warning may indicate a malfunction in one or the other brake circuit. Although the vehicle air system may continue to function, the vehicle should not be operated until the necessary repairs have been made. Always check the vehicle brakes after performing brake work and before returning the vehicle to service.

LEAKAGE CHECK

1. Coat the exhaust port and body of the brake valve with a soapy solution. See figure 4-15.
2. Make and hold a brake application to 80 psi (552 kPa).
3. Leakage permitted is a one inch (25.44 mm) bubble in three seconds.

If the brake valve has excessive leakage, it can be repaired.

REMOVAL

1. Block the coach wheels and vent the air system reservoirs by opening the drain cocks.
2. Disconnect all supply and delivery structural lines at the brake valve.

NOTE: Tag all air lines and their relation to the brake valve for reconnection.

3. Remove the mounting bolts and the brake valve.

DISASSEMBLY

1. If the entire brake valve and lever assembly was removed from the vehicle, remove the stop light switch and remove the three capscrews securing the treadle assembly to the basic brake valve.
2. Remove the screw securing the exhaust diaphragm and washer to the exhaust cover.
3. Remove the four screws that secure the exhaust cover to the lower body.
4. Remove the emergency inlet and exhaust valve assembly from the lower body.
5. Disassemble the emergency inlet and exhaust valve assembly by removing the retaining ring. Separate the washer, O-ring retainer, both O-rings, the spring and the valve retainer.
6. Remove the four hex head capscrews securing the lower body to the upper body and separete the body halves.
7. Remove the rubber seal ring from the lower body.
8. While applying thumb pressure to the No. 1 piston, lift out and up on the three lock tabs of the No. 1 piston retainer.
9. Using a 3/8" wrench, hold the ESNA nut on the threaded end of the stem on top of the No. 1 piston. Insert a screwdriver in the exhaust passage through the center of the valve and engage the slotted head of the stem.

WARNING: The combined force of the internal springs is approximately 50 lbs. (22.6 kg). Care must be taken when removing the ESNA nut as the spring forces will be released. The No. 1 piston and relay piston must be manually or mechanically contained while the nut and stem are being removed.

10. Rotate the screwdriver counterclockwise and remove the stem, stem spring, spring guide, and ESNA nut.
11. Remove the relay piston, relay piston spring from the upper body.
12. Disassemble the No. 1 piston by rotating the spring seat nut counterclockwise. Separate the spring seat nut, spring seat, rubber spring and remove the piston O-ring.
13. Remove the large and small O-rings from the relay piston.
14. Remove the retaining ring securing the service brake inlet and exhaust valve assembly in the upper body and remove the valve assembly.
15. Disassemble the service brake inlet and exhaust assembly by removing the retaining ring and separating the washer, O-ring retainer, both O-rings, valve spring and valve retainer.

CLEANING AND INSPECTION

Wash all metal parts in cleaning solvent and dry them. Inspect all parts for excessive wear or deterioration. Check the springs for cracks, corrosion, or a permanent "set." Replace all rubber parts.

REASSEMBLY

Prior to assembling the brake valve, coat all O-rings, O-ring grooves, piston bores and metal-to-metal surfaces with silicone base lubricant, TMC/MCI Part No. 21-7512-11.

1. Reassemble the service brake inlet exhaust valve assembly by first placing the valve retainer and the valve spring over the inlet and exhaust valve.
2. Place the O-ring retainer with the O-ring grooves away from the spring, over the inlet and exhaust valve and install the

O-rings in their proper grooves.

3. Place the washer over the inlet and exhaust valve, against the O-ring retainer and O-rings, and install the retaining ring.

4. Install the service brake inlet and exhaust assembly in the upper body and replace the retaining ring to secure it. Be sure the retaining ring is seated completely in its groove.

5. Install the large and small O-rings on the No. 2 relay piston.

6. Replace the No. 1 piston O-ring in the piston O-ring groove.

7. Install the rubber spring, concave side down, in the No. 1 piston. Place the spring seat, flat side up, over the rubber spring.

8. Install the No. 1 piston spring seat nut, with its hex closest to the spring seat, and rotate clockwise until the top surface of the spring seat is even with the top surface of the piston.

9. Place the No. 1 piston return spring in the upper body piston bore.

10. Install the No. 1 piston, spring seat out, over the return spring and press the piston into the body bore.

11. Place the No. 2 relay piston return spring in the upper body and place the No. 2 relay piston over the spring, so that the concave side of the piston is against the spring.

12. Compress both the No. 1 piston and relay piston into the upper body and hold them compressed, either manually or mechanically.

13. Place the stem through the exhaust passage of the lower body so that the threaded portion is visible at the No. 1 piston.

14. Using a screwdriver to engage and hold the slotted head of the stem, install the stem spring and spring seat. Make certain all three lock taps have engaged and outer lip of the body.

15. Reassemble the emergency brake inlet and exhaust valve assembly as referenced in steps 1, 2 and 3 of this section.

16. Install the emergency brake inlet and exhaust valve assembly in the lower body.

17. Place the exhaust cover on the lower body and install the four machine screws with lockwashers, to secure it to the body.

18. Tighten the four machine screws to 20-30 inch pounds (2.3-3.4 Nm) torque.

19. Install the exhaust diaphragm and diaphragm washer to the exhaust cover using the Phillips head screw and lockwasher.

20. Install the seal ring in the lower body and secure the lower body to the upper body using the four hex head capscrews and lockwashers.

21. Tighten the four capscrews to 70-100 inch pounds (7.9-11 Nm) torque.

22. Install the lever assembly to the basic brake valve using the three capscrews and lockwashers and tighten to 80-100 inch pounds (9-11 Nm) torque.

23. Install stop light switch.

SHUTTLE VALVE

The shuttle valve is located under the entrance floor in the tire compartment (figure 4-16). Under normal conditions the shuttle valve does not play an active role in the braking system. When a loss of air is experienced in the service brake system creating a pressure difference of 30 to 40 psi (207 kPa) between the service and emergency brake systems, the shuttle valve piston is moved upward. This allows air pressure from the parking tank to be modulated by the brake valve to apply the rear brakes.

Virtually no maintenance is required on the shuttle valve. There is a breather hole on the body of the valve and some air may exhaust from it (listen for hissing sound). If the leak continues while the brakes are fully applied, the valve should be removed, disassembled, and the O-rings replaced.

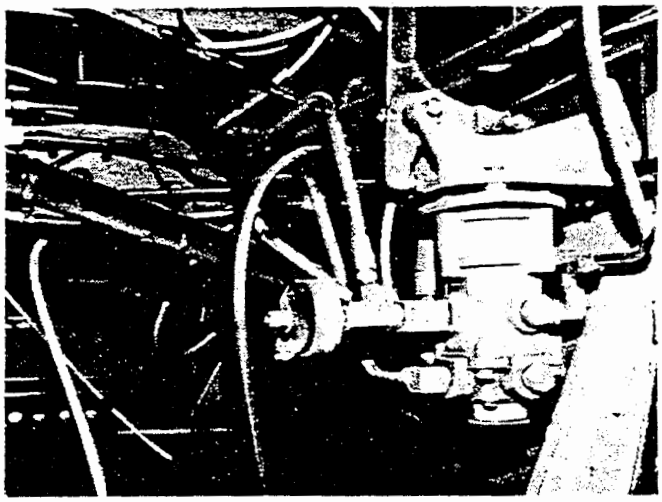


Figure 4-15. Brake Valve Installed.

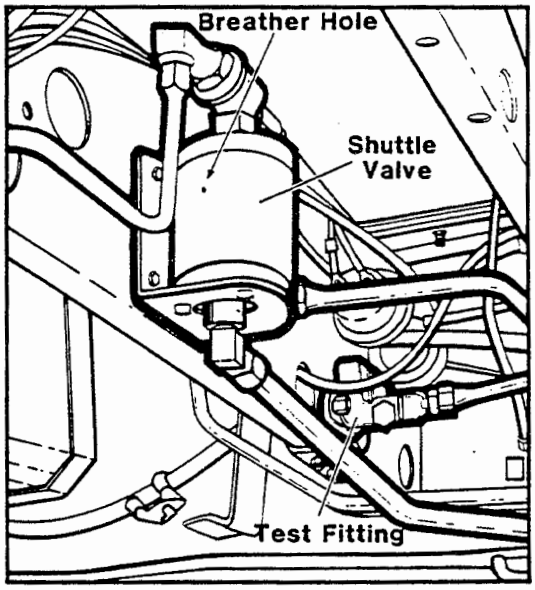


Figure 4-16. Shuttle Valve Installed.

TESTING

The valve can be tested to see if the piston in the valve shuttles (moves) to allow parking brake air pressure into the brake lines, by simulating an emergency loss of air pressure from the service tanks.

1. Place an air pressure gauge in the brake line between the shuttle valve and the check valve.

2. Build up air pressure until the governor cuts out.

3. Turn off the engine and vent the dry and wet tanks by opening the drain cocks.

4. Apply the brakes and check the air pressure gauge. Air pressure from the parking brake tank will apply the rear brakes as if braking in an emergency situation (loss of service brakes). The brake valve has a modulating feature; as more pressure is applied to the brake valve, there is an increase in brake line pressure.

Once the drain cocks are closed and pressure built up to normal in the service tanks, the piston in the shuttle valve will

close the emergency brake air line on the first service brake application.

For shuttle valve disassembly, refer to figure 4-17.

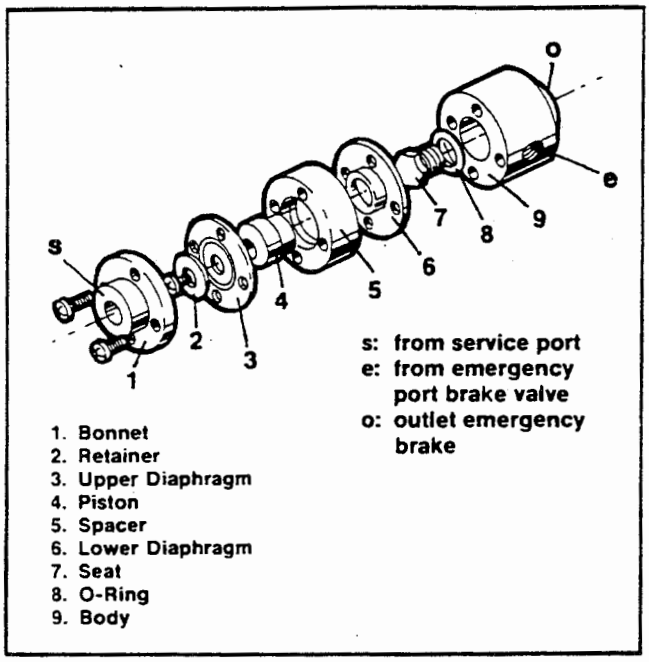


Figure 4-17. Shuttle Valve Parts.

QUICK RELEASE VALVES

The quick-release valves, used for the entrance door and the park brake systems, are found in the tire compartment. These valves speed up the release of air pressure.

In the parking brake system, when a brake valve application is released, the exhaust ports of the quick-release valves open and the air pressure accumulated in the brake chambers is exhausted through the quick-release valves, rather than exhausting back through the brake valve.

A line from a delivery port of the brake valve is connected to the top port of each quick-release valve. The two side ports are for brake chamber connections and the bottom ports are the exhaust.

OPERATION

When a brake valve application is made, air pressure enters the top port of the quick-release valve, moves the diaphragm down, closing the exhaust port. At the same time this air pressure forces the edges of the diaphragm down and flows past into the brake chambers.

As soon as the brake chamber pressure beneath the diaphragm equals the air pressure being delivered by the brake valve, the diaphragm spring forces the outer edges of the diaphragm against the body seat. The exhaust port is still sealed by the center portion of the diaphragm. When the brake valve is released, air pressure above the diaphragm is exhausted. Now, the pressure under the diaphragm raises it and the exhaust port opens allowing brake chamber pressure to release.

MAINTENANCE

Every year or after 50,000 miles (80,000 km) remove the quick-release valve, dismantle it and clean all parts. The diaphragm should be replaced if worn or deteriorated. See figure 4-18.

SERVICE CHECK

1. Apply the parking brake and note the activation of the brake chambers served by the quick-release valve.
2. Release the brake and observe that the air pressure is quickly exhausted through the quick-release valve.
3. Make and hold a brake application and check the exhaust port of the quick-release valve for leakage.

If the quick-release valve does not function properly or leaks excessively, it should be replaced or repaired as outlined below.

REMOVAL AND INSTALLATION

1. Block the coach by means other than the brakes.
2. Vent the air brake system.
3. Disconnect the air lines from quick-release valve.
4. Remove mounting bolts and valves.

To reinstall, mount quick-release valve with its exhaust port pointing down. Connect the brake valve to the top port and brake chamber lines to side port. Make sure exhaust port is not restricted.

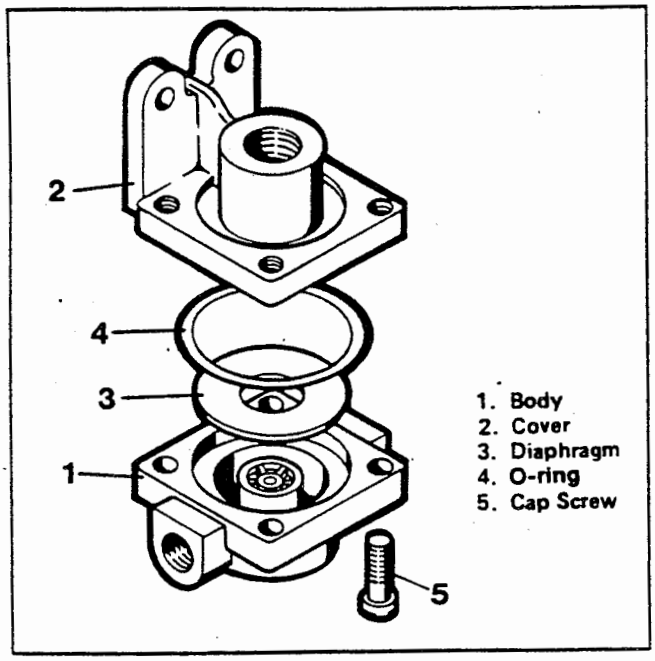


Figure 4-18. Quick Release Valve.

DISASSEMBLY AND REPAIR

1. Remove the cover using a wrench on the square portion of the exhaust port. Remove diaphragm and O-ring.
2. Clean all parts in cleaning solvent. Inspect the diaphragm, especially the lower part that contacts the exhaust seat, for wear or deterioration.

3. Check the exhaust seat for pitting or nicks. This seat should be smooth and sharp. If not, use a fine piece of emery cloth to restore its finish. Clean or replace as necessary.

To reassemble, position diaphragm and O-ring in place. Install cover and tighten securely.

R-12 REAR BRAKE RELAY VALVE

The R-12 brake relay valve is mounted on the center of the rear baggage compartment bulkhead. Application and release of the drive axle (and trailing axle) brakes are made through the relay valve. Lines from the dry air tank are connected directly to the valve providing high pressure air close to the drive axle (and trailing axle) brake chambers at all times. The relay valve is connected to the brake application valve (located in front tire compartment) by an air line which delivers air pressure to the relay valve. The relay valve provides a rapid application of the drive and trailing axle brakes and acts as a quick-release valve permitting rapid release of air pressure from the rear brake chambers.

MAINTENANCE

Every 20,000 miles (32,000 km) check the relay valve for proper operation and leakage. If valve leakage occurs, disassemble the valve, clean and inspect all parts. Refer to figure 4-19. Install new rubber parts and replace any other part found worn or damaged.

SERVICE CHECK

1. Apply the parking brake push-pull control valve by pulling up on plunger.
2. Coat the relay valve exhaust port with a soap solution to check for inlet valve and O-ring leakage.
3. Push to release the parking brake control valve and again check at the exhaust port for leakage of the exhaust valve.
4. Apply soap solution around the valve where the cover joins the body to check for seal ring leakage. With the parking brake in "release" position, apply soap solution to the quick-release exhaust port to check the diaphragm exhaust seat.

If the relay valve does not function properly, or if leakage is excessive, the valve must be disassembled and repaired.

REMOVAL AND DISASSEMBLY

1. Block the coach by means other than the brakes.
2. Vent the air brake system.
3. Tag the lines to aid in reconnection, then disconnect and remove all air lines.
4. Remove the relay valve from the coach.

NOTE: Prior to disassembly, matchmark the location of the mounting bracket to the cover and the cover to the body.

5. Remove the four capscrews and lockwashers securing the cover to the body.
6. Remove the cover, sealing ring, and mounting bracket.
7. Remove the piston and O-ring from the body.
8. While depressing the exhaust cover, remove the retaining ring and slowly relax the spring beneath the exhaust cover.
9. Remove the exhaust cover assembly and O-rings.
10. Remove the inlet/exhaust valve return spring from the body.
11. Remove the inlet/exhaust valve from the body.
12. Remove the valve retainer from the inlet/exhaust valve.

CLEANING AND INSPECTION

1. Wash all parts in mineral spirits; dry all rubber parts.
2. Inspect all parts for signs of wear and/or deterioration. Inspect springs for cracks, distortion or corrosion.
3. Inspect inlet seat and exhaust seat for nicks and burrs and replace as necessary. All rubber parts and any part showing signs of wear or deterioration should be replaced.

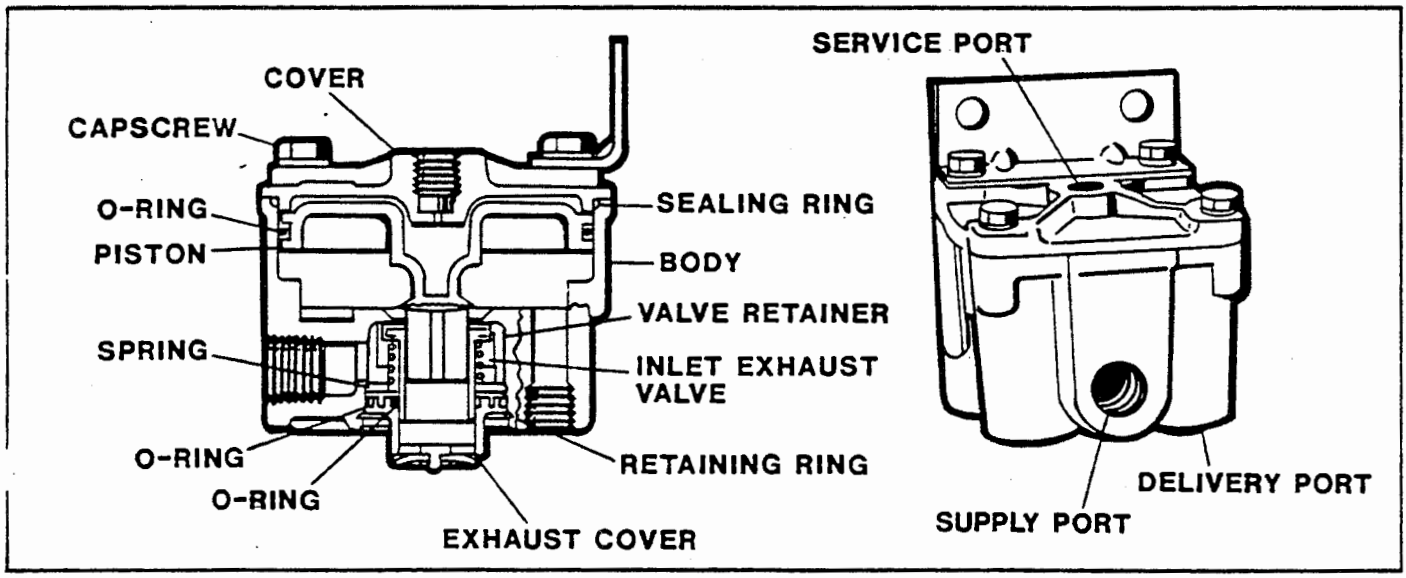


Figure 4-19. Rear Brake Relay Valve R-12.

REASSEMBLY

1. Install large O-ring on piston.
2. Install inner and outer O-rings in the exhaust cover assembly.
3. Install the sealing ring on the cover.
4. Install piston in body, taking care not to damage the O-ring.
5. Aligning the matchmarks made during disassembly, install the cover on the valve body and the mounting bracket on the cover.
6. Secure the mounting bracket and cover to the body using the four capscrews and lockwashers. Tighten to 80-120 inch pounds (9-14 Nm) torque.
7. Install the valve retainer on the inlet/exhaust valve and install in the body.
8. Install the inlet/exhaust valve return spring in the body.
9. Install the exhaust cover assembly in the body taking care not to damage the O-ring.
10. While depressing the exhaust cover, install the retaining ring. Make certain the retainer is completely seated in its groove in the body.
11. Test the valve as outlined in the Service Check section before returning the valve to service.

SAFETY VALVE

Normally, the safety valve remains inoperative and only functions if the reservoir pressure rises above its normal limit. The safety valve protects the air system against air pressures above 150 psi (1,035 kPa). The safety valve consists of a spring loaded ball which lifts and permits air to exhaust if the pressure in the reservoir rises above its setting.

Should the reservoir pressure below the ball valve rise to a point above the setting of the safety valve, the force developed will overcome the force of the regulating spring holding the ball on its seat and the ball will lift. This permits air to pass up into the spring cage and exhaust through the exhaust port. As soon as this reduces the pressure to the setting of the safety valve, the regulating spring forces the ball back on its seat stopping the exhaust.

TESTING

The safety valve may be tested to be sure it is operative by pulling the exposed end of the valve stem. This removes the spring load from the ball and permits the valve to exhaust. If the safety valve does not "blow off" when this is done, the ball is stuck on its seat. The complete valve should be removed and dismantled for cleaning.

Leakage at the exhaust port in the spring cage should not exceed a three inch soap bubble in three seconds.

DISASSEMBLY AND REPAIR

Every 50,000 miles (80,000 km) the safety valve should be removed and thoroughly cleaned. Refer to figure 4-20.

1. Unscrew the spring cage from the body of the safety valve.
2. Lift ball valve from body and remove spring, spring seat, and release pin from spring cage.
3. Clean all parts in cleaning solvent.
4. Examine the ball valve for signs of pitting or scratches. If the ball valve cannot be reconditioned, it should be replaced.
5. Check the body and spring cage for cracks. Be sure the exhaust port in the spring cage is not plugged.

REASSEMBLY

1. Place the ball valve in the body of safety valve.
2. Place spring release pin and spring seat in spring cage with the adjusting screw assembly.
3. Position the spring seat over the ball valve and screw the spring cage to the body.

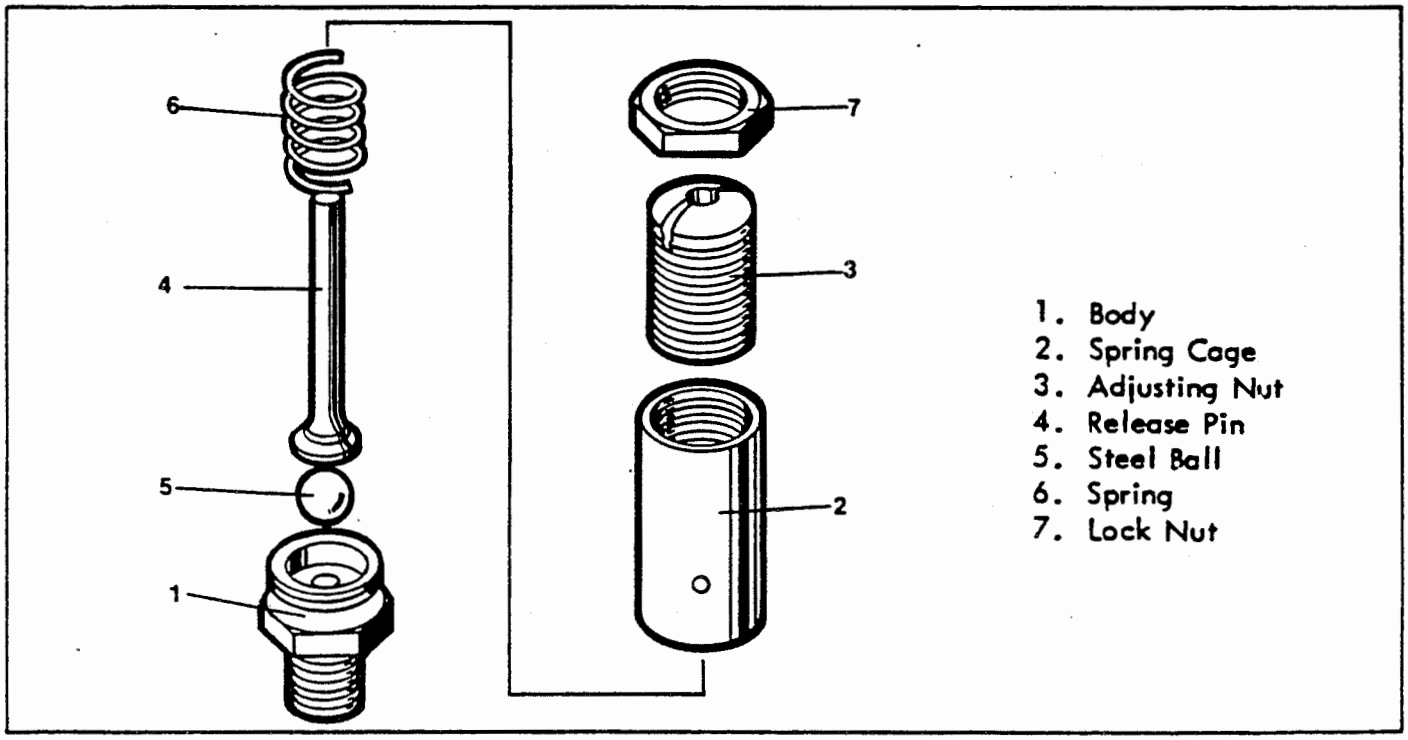


Figure 4-20. Safety Valve.

ADJUSTMENT

The pressure setting of the safety valve is stamped on the cover wrench flat (closest to the pipe thread). The correct pressure setting is 150 psi (1,035 kPa).

To adjust, the safety valve must be connected to an air system with air pressure in excess of desired setting. It is important that an accurate gauge be used to check pressure settings while making adjustments.

To raise pressure setting, loosen lock nut, turn adjusting nut clockwise to obtain correct pressure setting and tighten lock nut.

To lower pressure setting, loosen lock nut, turn adjusting nut counterclockwise to obtain correct pressure setting and tighten lock nut.

LOW AIR PRESSURE SWITCH AND ALTERNATOR CONTROL

The low pressure switch and alternator control gives an automatic warning to the driver when air pressure is below the minimum for safe vehicle operation. It operates an electric buzzer and warning lights.

When reservoir air pressure under the diaphragm is above 70-75 psi (483-517 kPa), the electrical contacts remain open because the force exerted by the air pressure overcomes the force exerted by the spring above the diaphragm. When the reservoir air pressure drops below 70-75 psi (483-517 kPa), the diaphragm spring exerts a force greater than the force exerted by the air pressure below the diaphragm. This causes the diaphragm to move down and close the electrical contact. This completes the electrical circuit to the buzzer and warning light informing the driver of the impending loss of air pressure. It also opens the alternator charging circuit.

OPERATION

Operation of the low air pressure switch and alternator control may be checked by reducing the reservoir pressure through application and release of the service brakes numerous times. Observe the air pressure gauge and when the air pressure drops below 70-75 psi (483-517 kPa); the tell-tale warning light and buzzer should come on.

The air gauge in the instrument panel reads dry tank pressure. In order to ascertain if there is a sufficient supply of air pressure to all accessories prior to driving the vehicle, the buzzer will sound and the tell-tale warning light will flash until 100 psi (690 kPa) air pressure is reached in the dry air system.

AIR LINE CHECK VALVES

The in-line check valves are placed in an air line to allow air flow in one direction and to prevent the flow of air in the opposite direction. An arrow indicating the direction of air flow is cast into the body of the valve.

Air flow in the normal direction moves the disc valve from its seat and the flow is unobstructed. Flow in the reverse direction is prevented by the seating of the disc valve. Refer to figures 4-21 and 4-22.

MAINTENANCE AND TESTING

Every six months, 1,800 operating hours or every 50,000 miles (80,000 km), disassemble, clean and inspect all parts. Replace any parts showing signs of wear or deterioration.

Depending upon installation, it may be necessary to completely remove the check valve so that the following checks may be made. With air pressure present at the outlet side of check valve and the inlet side open, coat the open end of the check valve with soap solution; a 1" bubble leakage is permitted in not less than five seconds.

If the check valve leaks excessively, the valve should be replaced with a new check valve or repaired.

REMOVAL AND DISASSEMBLY

1. Block the coach by means other than the brakes.
2. Apply parking brakes.
3. Vent all reservoirs.
4. Disconnect air lines and plug ends to prevent any foreign particles from entering the system.
5. Check and, if necessary, clean or replace air lines to valve.
6. Unscrew cap nut from body and remove gasket.
7. Remove shims (if present), disc valve, valve seat (if present) spring, and valve stop bushing (if present).

CLEANING AND INSPECTION

1. Wash all metal parts in cleaning solvent.
2. Rubber parts should be wiped clean.
3. Inspect disc valve and seat for signs of wear or deterioration.
4. Check spring for cracks, corrosion or distortion.
5. Inspect body and cap nut for cracks or damage.
6. Replace all parts that are damaged or worn.

To reassemble, position parts in proper order in body, install new grommet on cap nut, screw cap nut into body and tighten securely.

NOTE: Care should be taken that valve is not lodged between capnut and body when assembling.

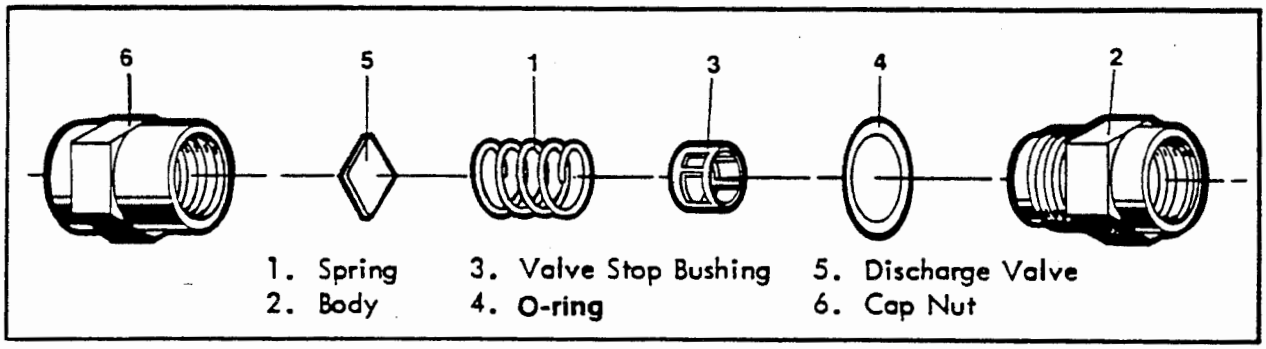


Figure 4-21. Main Air Supply Check Valve.

MC-9 MAINTENANCE MANUAL

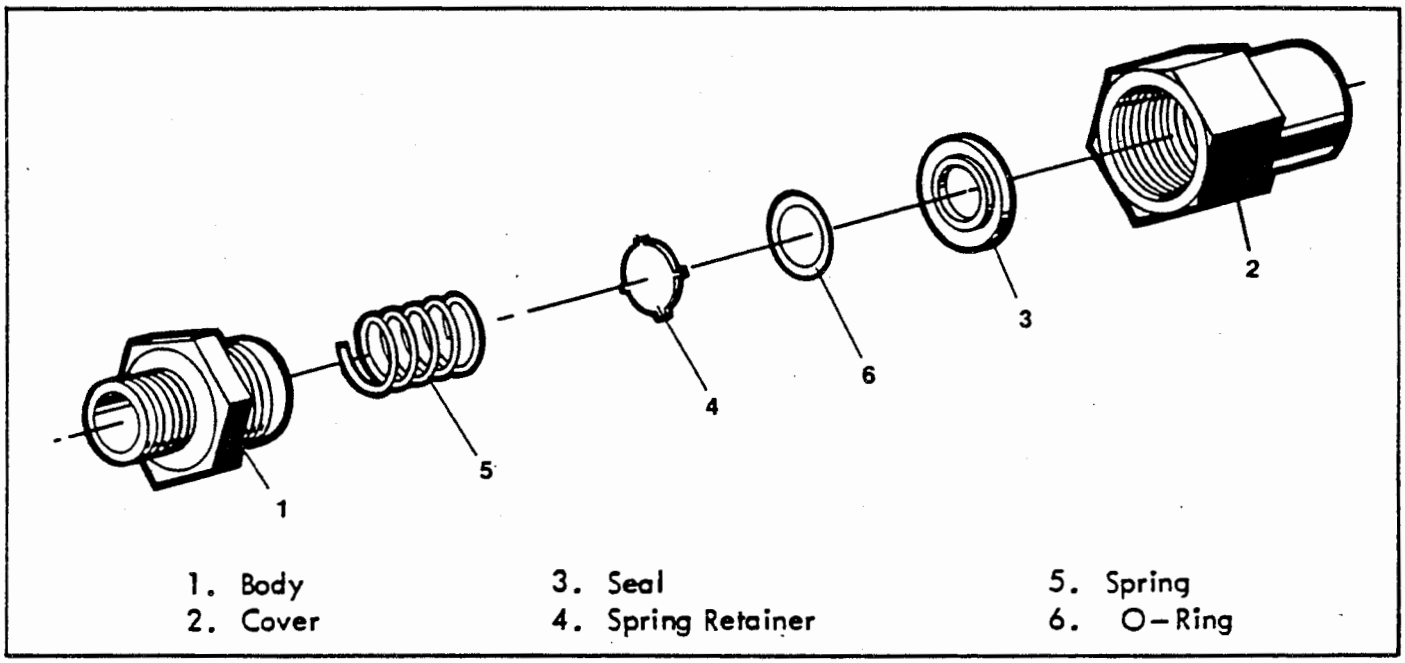


Figure 4-22. Air Line Check Valve.

When installing valve, make certain that it is installed correctly with respect to the desired air flow. An arrow indicating the direction of air flow is cast into the body of the valve.

SERVICE BRAKE STOP LIGHT SWITCH

The stop light switch (figure 4-23) operates in conjunction with the brake valve and stop light by completing the stop light electrical circuit when a brake application is made.

When air pressure from the brake valve enters the cavity on the side of the diaphragm, the diaphragm changes its position, overcoming the force of the spring and moving the contact plunger until the electrical contacts close. This closes the stop light circuit. When the air pressure acting on the diaphragm is exhausted by the brake valve, the spring forces the diaphragm and the contact plunger back to their normal position and the stop light circuit is opened. See figure 4-24.

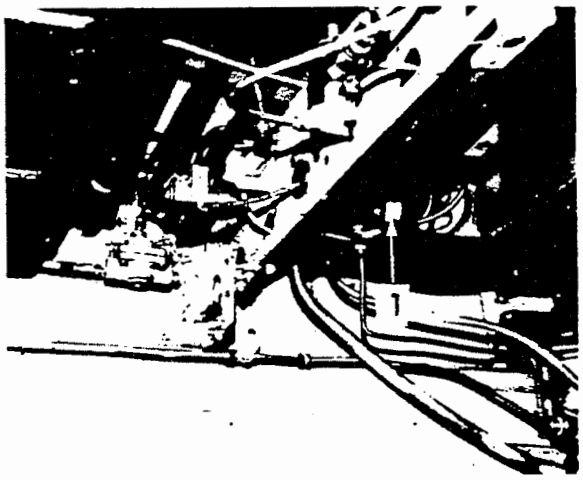


Figure 4-23. Stop Light Switch Location in Front Tire Compartment (1).

TESTING

Apply the brake valve and note that with the first downward movement of the brake valve pedal or treadle, the stop light immediately lights. Release the brake valve and note that the stop light goes off. With the brake applied, no leakage is permitted at the stop light switch.

REMOVAL AND REPAIR

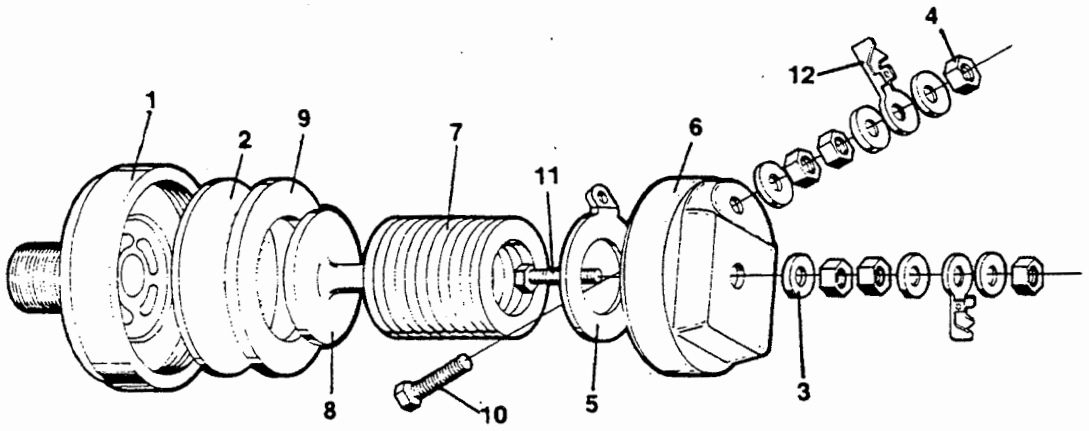
1. Disconnect electrical connections at the stop light switch.
2. Unscrew switch.
3. Remove the cover from the body and lift out the spring contact plunger, diaphragm ring, and diaphragm.
4. Clean all metal parts in cleaning solvent.
5. If diaphragm is cracked, worn or damaged, replace with new diaphragm.
6. Inspect the contact points for signs of pitting or wear. If pitting is not too severe, the contacts may be reconditioned by filing them with a fine file such as is used for distributor points. If they cannot be reconditioned, they should be replaced.
7. Check the spring for tension. If it has lost its tension, it should be replaced.
8. If the body or cover is cracked or damaged, it should be replaced.

TEST OF REBUILT STOP LIGHT SWITCH

Both operating and leakage tests, as indicated under Testing, must be made after rebuilding or repairing the stop light switch. The switch must meet the following specifications:

A. No leakage is permissible at the stop light switch with the brake applied.

B. The stop light switch contacts should close at not more than 5 psi (34.5 kPa) of air pressure.



1. Body
2. Diaphragm
3. Washer
4. Nut
5. Terminal Connector
6. Cover
7. Spring
8. Contact Plunger Assy.
9. Washer
10. Terminal Screw
11. Terminal Screw
12. Cable Terminal

Figure 4-24. Stop Light Switch Parts Breakdown.

PRESSURE REGULATING VALVES

Pressure regulating valves control the pressure of compressed air. They remain opened until their pressure setting is reached.

Listed below are the locations where pressure regulating valves are used and the pressures to which they must be set:

1. Blower belt tension ..... 21 psi (144.8 kPa)
2. A/C compressor belt tension ..... 95 psi (655 kPa)
3. Parking brake..... 80-85 psi (552-586 kPa)
4. Trailing axle bellows ..... 35 psi (241.3 kPa)
5. Trailing wheel brake system ..... 21 psi (144.8 kPa)
6. Trailing axle unloading system (optional) ..... 15 psi (103.3 kPa)
7. Lavatory door control (optional) ... 21 psi (144.8 kPa)
8. Lavatory air flush (optional) .....11 psi (75.8 kPa)

The pressure setting is determined in the pressure regulating valve by the tension of an internal spring which in turn is controlled by an adjusting screw at the top of the valve. Turning the adjusting screw clockwise raises the pressure setting; counterclockwise reduces the setting. The locknut must be tightened after final adjustment is accomplished. See figures 4-25, 4-26 and 4-27.

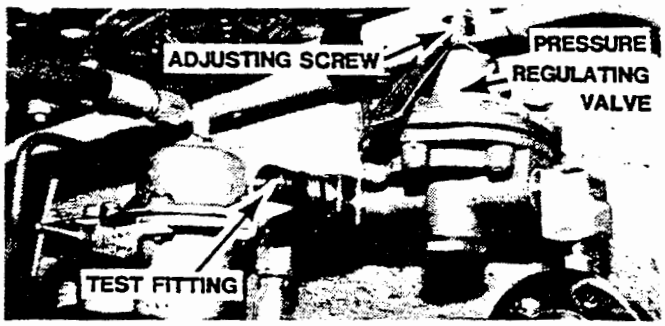


Figure 4-25. Pressure Regulating Valve (typical).

MAINTENANCE

Every 50,000 miles (80,000 km) or yearly:

1. Remove and disassemble the pressure regulating valve and clean all parts. Replace diaphragm.
2. After valve is assembled, check the pressure setting of the valve with a test gauge. Adjust the valve to the specified pressure setting.
3. Install valve and check to see that the mounting bolts and pressure adjusting screw are secure and that there is no air leakage.

REMOVAL AND TESTING

1. Block the coach by means other than the brakes.
2. Vent the air system.
3. Disconnect air lines to pressure regulating valve.
4. Remove pressure regulating valve mounting bolts and remove the valve.

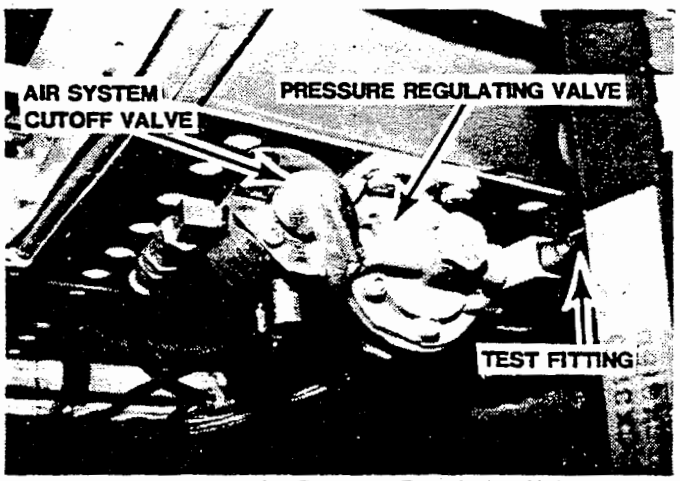


Figure 4-26. Pressure Regulating Valve

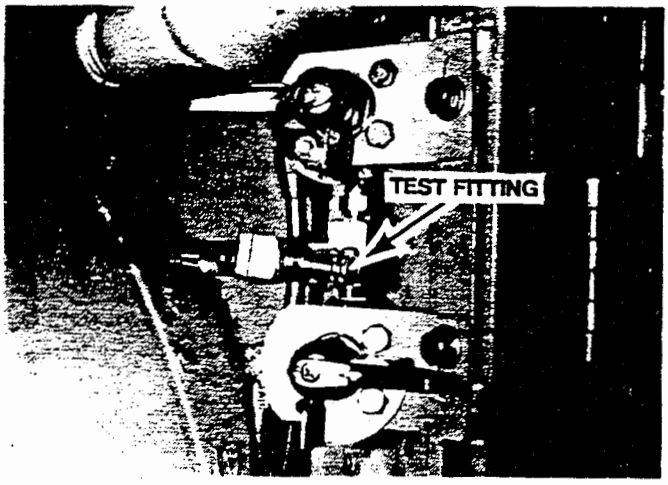


Figure 4-27. Test Fitting Remote From Pressure Regulator Valve.

TEST EQUIPMENT REQUIRED

A tee fitting and plug are installed in the outlet port of the pressure regulating valve. This enables installation of a test gauge for adjusting or checking the pressure regulating valve setting.

The following items of equipment are required to check the pressure regulating valve air pressures.

A. TMC/MCI Part No. 16C-2-95 - Charging Hose - (Yellow Jack Hose) HCL-36.

B. TMC/MCI Part No. 16C-2-96 - Pressure Gauge - 0-400 lbs. with R-12 and R-22 Pressure Scales (No. 172 CA 2½").

NOTE: Any suitable gauge and hose may be used for this procedure. The above gauge and hose can be found in Air Conditioning Test Kit No. 16C-2-92.

Operators who do not already have the test kit in their inventory may purchase the required items. They are available from Universal Coach Parts, Inc., Northlake, Illinois and in Canada from Motor Coach Industries, Service Parts Division.

TEST PROCEDURE

1. Remove the dust cap from the test fitting. Attach pressure gauge No. 16C-2-96 to the test point by means of the pressure hose No. 16C-2-95. If the pressure reading is not correct, perform steps 2 and 3. If correct, disconnect test equipment (step 4).

2. Loosen the locknut, turn the adjusting screw counterclockwise to reduce the pressure approximately 10 psi (69 kPa) below the pressure required.

3. Turn the adjusting screw clockwise to increase the pressure slowly until the required pressure setting is reached. Tighten the locknut.

4. Remove the gauge and hose and replace the dust cap on the test fitting.

CLEANING AND INSPECTION

1. Wash all metal parts in cleaning solvent.

2. Examine the diaphragm and, if cracked worn or damaged, replace with new diaphragm.

3. Inspect inside of valve for water or damage. If the valve is excessively grooved, or pitted, it should be replaced.

4. Replace any other parts that appear worn or damaged. (Screen and inlet parts should also be removed and cleaned.)

RESERVOIRS

Reservoirs store compressed air so there will be an ample supply for immediate use. Four air reservoirs are used on the coach; two in the service brake system, one in the park brake system, and one in the accessory air suspension system. See figure 4-28.

Air compressors pass a certain amount of oil in order to lubricate the cylinder walls and piston rings. Also, depending on the humidity, the atmosphere entering the compressor contains a certain amount of water. Thus, oil and water normally pass into the reservoir in the form of vapor because of the heat generated during compression. After reaching the reservoir, the vapor cools and condenses in the form of an oil and water emulsion and is drained by a drain cock at the bottom of the reservoir.

In addition to periodic draining, the reservoirs should be checked for mounting integrity, for outer surface corrosion and damaged lines and fittings.

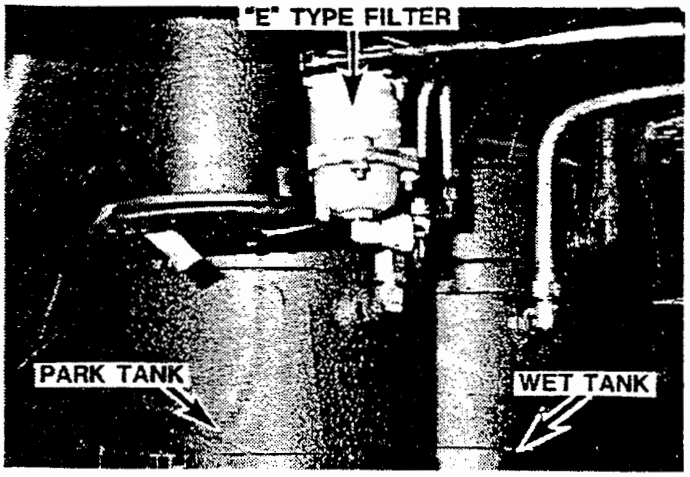


Figure 4-28. Reservoirs in Front Bogie Area.

FRONT AND TRAILING AXLE BRAKE CHAMBERS

Brake chambers convert compressed air pressure into mechanical force and movement which applies the vehicle brakes. Brake chambers on the front axle and the trailing axle are of the clamp ring type. See figure 4-29. The diaphragm is held between two plates by a clamping ring, two nuts and two bolts.

Air pressure enters the pressure side of the brake chamber against the diaphragm which moves the push rod assembly forward. The push rod is connected to a slack adjuster which is attached to a camshaft that rotates the brake cam and applies the brakes.

When air pressure is released from the brake chamber, the push rod return spring in combination with the brake shoe return spring returns the diaphragm, push rod, slack adjuster and brake cam, releasing the brakes.

Push rod travel should be kept as short as possible without causing brake drag. Excessive push rod travel shortens diaphragm life, gives slow braking response and wastes air.

TESTING

Check push rod-to-slack adjuster alignment in both the applied and released positions to be sure the push rod moves out and returns properly and without binding. Also check the angle formed by the slack adjuster arm and push rod. It should be 90° or greater when the chamber is in the applied and released positions.

MAINTENANCE

Every 50,000 miles (80,000 km) or more often, depending on the type of operation, disassemble brake chambers and clean all parts. Install a new diaphragm, or any other rubber parts, if they are worn or deteriorated. When the diaphragm or spring are replaced in one brake chamber, they should be replaced in the corresponding brake chamber on the same axle.

Apply the brakes and check that the brake chamber push rod moves out promptly without binding. Release the brakes and note that the push rod returns to the released position promptly and without binding. Check push rod travel to be sure it is at a minimum without brake drag.

With a full pressure application, check the brake chamber for leakage. No leakage is permissible.

CAUTION: If leakage is detected around the flange, or clamping ring, the bolts should be tightened evenly but only enough to stop the leakage. Otherwise the diaphragm, flange sealing surface or clamping ring could be distorted.

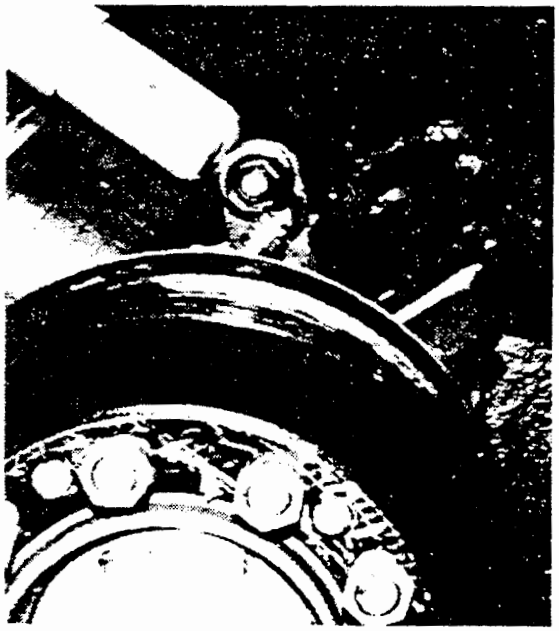


Figure 4-30. Brake Chamber Installed at Trailing Axle.

REMOVAL AND INSTALLATION

1. Block the coach by means other than the brakes.
2. Disconnect the air line and push rod yoke. Refer to figure 4-30.
3. Remove brake chamber.
4. For installation, mount brake chamber to mounting bracket.
5. Install yoke and its lock nut on push rod and connect to slack adjuster arm.

Check the angle formed by the push rod and slack adjuster. The angle should never be less than 90° when full air pressure is applied to the brake chamber when the brakes are cold and properly adjusted.

DISASSEMBLY AND REPAIR

After cleaning the exterior of the brake chamber, matchmark the parts in such a way that they can be assembled the same way.

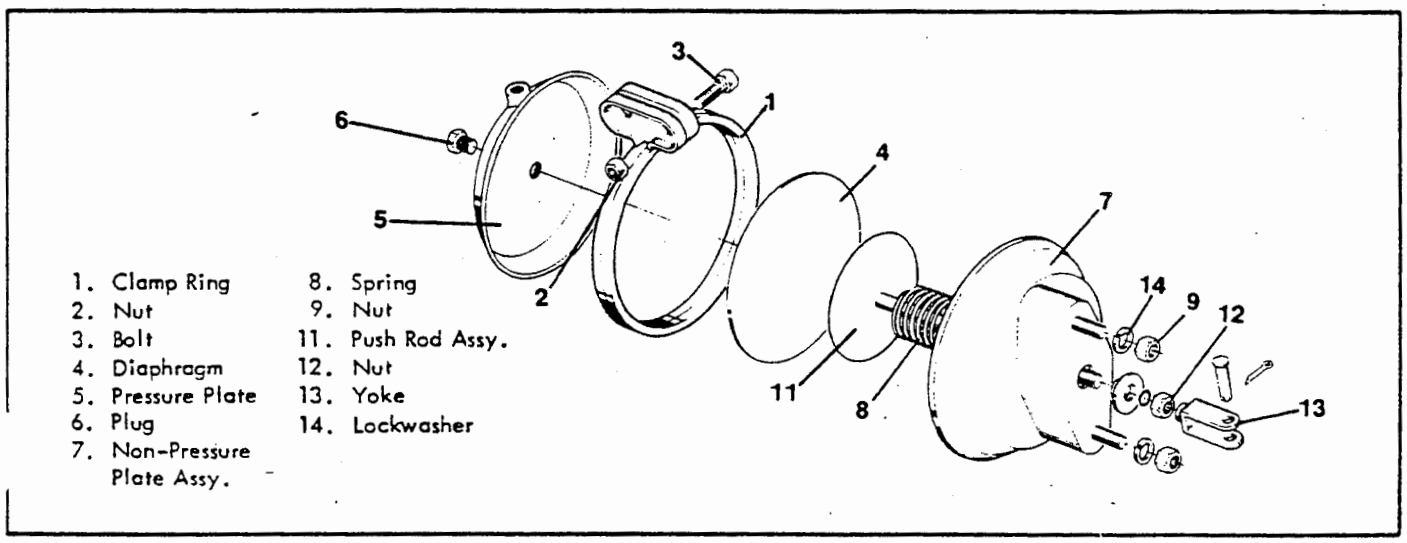


Figure 4-29. Front and Trailing Axle Brake Chambers.

If the brake chamber is to be dismantled on the vehicle (for example to change the diaphragm or spring), first back off the slack adjuster to relieve the return spring pressure against the pressure plate, then follow disassembly procedure below.

1. Pull out push rod and clamp it at the non-pressure plate with vise or vise grip pliers. If necessary, use air pressure to move the push rod out.

CAUTION: Jaws of vise or vise grip pliers should be covered or taped to prevent damage to the push rod.

2. Remove clamp ring nuts and bolts. Spread clamp ring slightly, just enough to slip it off the plates. It is sometimes necessary to use a screw driver and gradually pry under the clamp ring to remove it. If the clamp ring is to be reused, caution should be taken against bending it out of shape.
3. Remove pressure plate and diaphragm.
4. Remove yoke and lock nut from push rod.
5. Release grip on push rod and remove push rod assembly, spring and other parts.
6. Clean all metal parts and inspect for damage. Damaged parts should be replaced. If it is necessary to replace the return spring, be sure the correct replacement spring is used.

DRIVE AXLE BRAKE CHAMBERS

The driving axle brake chambers combine the functions of a conventional service brake chamber with a secondary diaphragm and locking mechanism to give service and parking brake operation.

Operation of the brake chambers under various conditions has been described earlier in this section.

MAINTENANCE

NOTE: The following procedure is applicable to all brake chambers on the coach.

Depending on experience and type of operation, the drain slot in the actuator non-pressure plate should be checked and cleaned of any restricting road grime, mud, ice, snow, etc.

Brakes should be adjusted as is customary with any brake chambers. Push rod travel should be as short as possible without dragging brakes. Excessive travel not only shortens the normal service life of diaphragms but gives slow braking response, wastes air, and could possibly result in decreasing brake torque.

Push rod to slack adjuster alignment should be checked in both the applied and released positions. The rod should move out and return properly without binding. Check the angle formed by the slack adjuster arm and push rod. It should be 90° or greater when the actuator is in the applied or the released position.

Every year or after 50,000 miles (80,000 km) depending on type of operation, disassemble the actuator, clean all parts and lubricate the locking mechanism. Install new diaphragms and other rubber parts if they are worn or deteriorated. A grease nipple is provided in the brake chamber for lubricating the interior with a high quality chassis lubricant.

When diaphragms or return spring or both are replaced, like parts in the corresponding actuator on the same axle should also be replaced.

REMOVAL

1. Block and hold the vehicle by means other than air brakes. With the actuators in the released position, disconnect or completely remove the air lines from parking and service ports of the chamber.

WARNING: Air will be exhausted from the line that is connected to the parking port when the control valve is operated. If this line is not removed, it should be secured in such a way that it will not whip and cause injury or damage as the air exhausts.

2. After disconnecting only the parking and service port lines, operate the parking control valve. The action will exhaust the isolated air supply and air from the locking port.
3. As a safety precaution, the service system should also be vented, if it is separate. Disconnect the air line at the actuator lock port.
4. Remove the yoke pin cotter pin and knock out the yoke pin.
5. Remove the mounting nuts, then the actuator.

DISASSEMBLY

1. Clean the chamber exterior of all road grime then mark it in such a way so it can be assembled in the same manner. Refer to figures 4-31 and 4-32.
2. Remove yoke and yoke lock nuts. Remove boot, splash guard and felt breather.
3. Remove auxiliary and service clamping ring nuts and bolts. Spread clamping rings slightly, just enough to slip them off the plates.

NOTE: It may be necessary to use a soft mallet driver to break the clamping rings loose. If the rings are being reused, care should be taken against bending them out of shape.

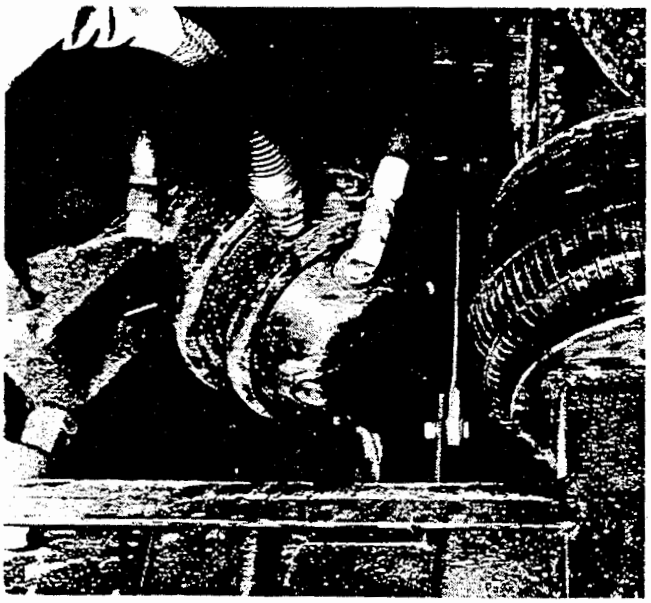
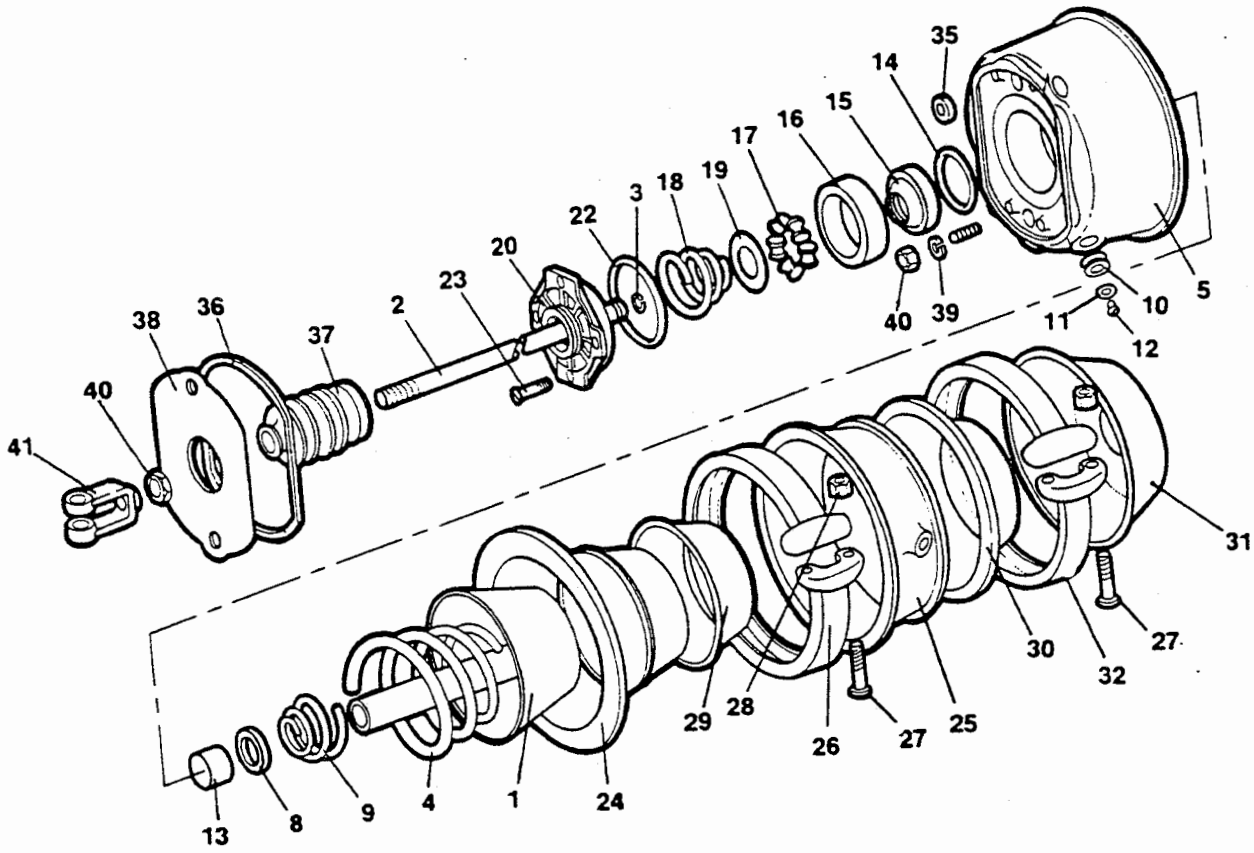


Figure 4-31. Drive Axle Brake Chamber.

4. After the clamping rings are removed, the auxiliary pressure plate, auxiliary diaphragm service pressure plate and service diaphragm are removed in that order.

A diaphragm separator may have been installed between the auxiliary and service diaphragms. When replacing the service diaphragm, check the old diaphragm for the presence of a bead (figure 4-33) molded into it. If the bead is present, a diaphragm separator is required and the new diaphragm must also have a bead.

When replacing both the service and auxiliary diaphragms, kits are available in either 2-piece or 3-piece configuration, and either kit may be installed. When replacing only the auxiliary



1. Shaft Assy.
2. Push Rod
3. Retaining Ring
4. Return Spring
5. Non-Pressure Plate Assy.
8. Wiper
9. Retaining Spring
10. Diaphragm
11. Washer
12. Screw
13. Bearing
14. O Ring
15. Piston
16. Collar
17. Roller
18. Spring
19. Washer
20. Cap
22. O Ring
23. Screw
24. Service Diaphragm
25. Service Pressure Plate
26. Service Clamp Ring
27. Bolt
28. Nut
29. Diaphragm Separator
30. Auxiliary Diaphragm
31. Auxiliary Pressure Plate
32. Auxiliary Clamp Ring
35. Felt Breather
36. Gasket
37. Boot
38. Splash Guard
39. Lockwasher
40. Nut
41. Yoke Assy.

Figure 4-32. Drive Axle Brake Chamber Components.

diaphragm, the replacement part is suitable for use with or without the diaphragm separator.

5. Place the remains of actuator on a smooth surface with the push plate down. Connect an air supply (shop air) line to the locking port.

6. By hand, press down the actuator non-pressure plate and at the same time apply air to the locking port. As the shaft is unlocked, ease the non-pressure plate back and remove the push plate and shaft assembly with push rod and return spring.

7. Hold the lock cap down against roller spring tension and completely remove all four capscrews before releasing and removing the cap.

8. Remove roller spring and spring seat washer. Remove all eight rollers.

9. Next cautiously apply air at the locking port to assist in removal of collar and piston, and to remove piston O-ring.

10. Inspect the bearing in shaft bore and remove it only if it is showing signs of wear.

NOTE: The push rod should not be removed from the shaft unless it is damaged. If the rod is removed it must be replaced.

11. To remove the rod, place a heavy washer over the rod against the shaft, then position a spacer and a second washer over the rod and beneath the yoke locknut. Turn the locknut down with a long handled wrench, pulling the push rod from the shaft.

12. The knurled T-bolts in the non-pressure plate can be removed and replaced if damaged.

REPAIR

1. Wash all metal parts in a cleaning solvent and dry. Any reusable parts should be wiped clean. Discard felt breather.

2. Inspect all parts for excessive wear or deterioration. Particular attention should be given to the piston and collar cores in the plate.

3. The air passage from the lock port to piston bore should be clean and not restricted. It may be necessary to remove the inspection plug to thoroughly clean this passage.

4. Rollers should all be replaced if one or more need replacing. Check the springs for cracks, distortion or corrosion. Replace all parts not serviceable.

REASSEMBLY

1. Line up parts as they were marked prior to disassembly.

2. Lubricate the piston and collar bores, shaft, piston O-ring and piston cavity with silicone base lubricant TMC/MCI Part No. 21-7512-11.

3. Position the O-ring in the piston with smooth end down. Place the collar in its bore in the plate.

4. Position all eight rollers in the groove formed by the top of the piston and collar rollers.

5. Position the cone shaped roller spring on the washer with the small end to washer.

6. Position the cap on the roller spring. Press the cap and hold while installing capscrews evenly.

7. Turn the non-pressure plate lock mechanism installed and position the return spring in the plate with the large end down.

8. Position the push plate and shaft over the spring and press down so the shaft moves through the lock. The lock should hold the shaft position against return spring. If not, check assembly at this point.

9. Install the service diaphragm, service pressure plate and clamping ring.

NOTE: If the service diaphragm has a bead molded into it (figure 4-30), a diaphragm separator must be used.

10. Install the auxiliary diaphragm, auxiliary pressure plate and clamping ring.

11. Tighten clamping ring bolts, in both clamping rings evenly.

12. Install the new breather felt, then the splash guard down over the boot.

INSTALLATION

CAUTION: On installation, actuators must be installed with the drain slot pointing down and towards the center line of the vehicle.

1. Mount chamber on the mounting bracket and tighten securely.

2. Fasten the actuator push rod yoke to the slack adjuster with the yoke pin. Lock the yoke pin with a cotter pin. The angle formed by the push rod and slack adjuster arm should be greater than 90 degrees.

3. Connect the air lines to the chamber. Take care that the correct line is installed in the correct port.

4. Adjust brakes.

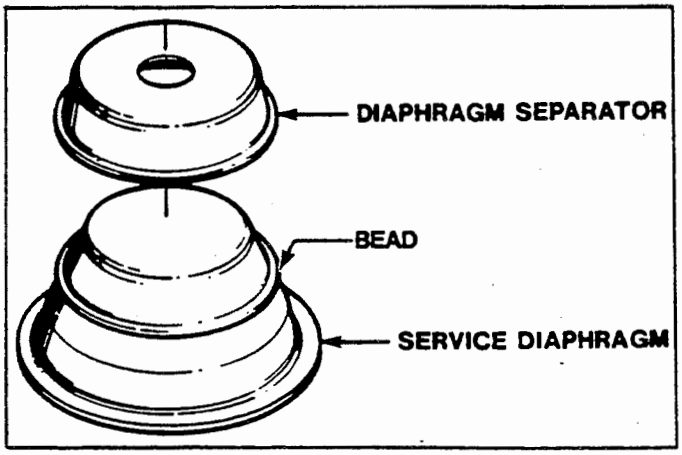


Figure 4-33. Diaphragm Configuration in Drive Axle Brake Chambers.

MC-9 MAINTENANCE MANUAL

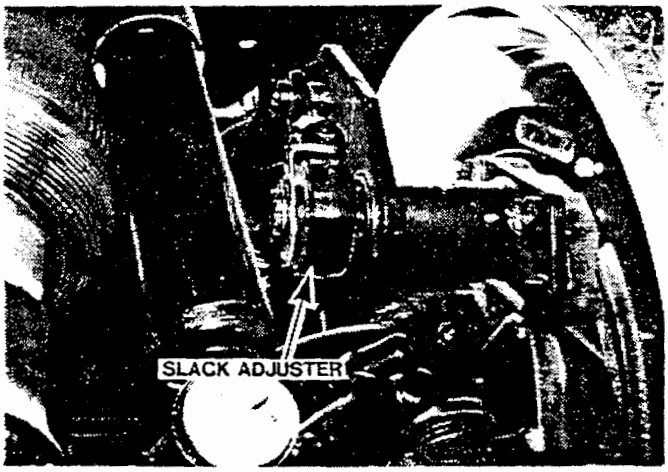


Figure 4-34. Manual Slack Adjuster Installed.

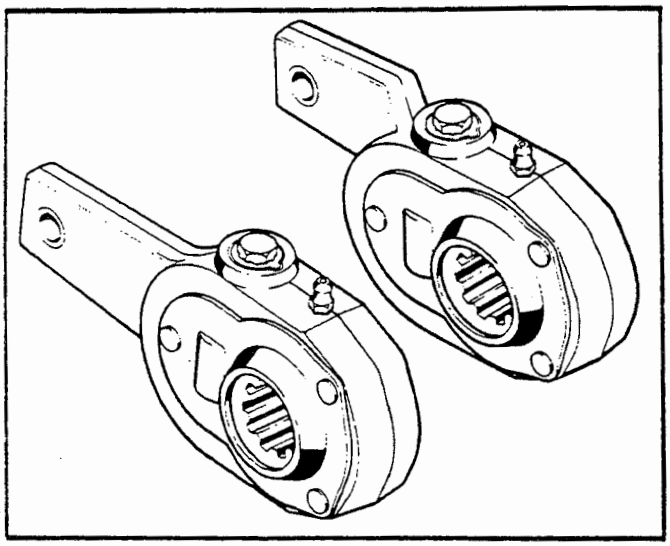


Figure 4-35. Typical Slack Adjusters.

SLACK ADJUSTERS (MANUAL)

Slack adjusters provide a quick method of adjusting brakes to compensate for brake lining wear (figures 4-34 and 4-35). The slack adjusters utilize worm gear drive to ensure maximum road service with a minimum of maintenance.

Slack adjusters must be lubricated once every 5,000 miles (8,000 km). The slack adjuster grease fittings may be lubricated with a standard shop grease gun. Only molybdenum disulphide grease should be used on the slack adjusters.

BRAKE ADJUSTMENT

CAUTION: Prior to adjusting the rear coach brakes, ensure that system air pressure is above 65 psi (449 kPa).

While making brake adjustments, the wheel must be in a jacked-up position.

1. Install the wrench on the adjusting screw and disengage the locking sleeve by depressing it. While the locking sleeve is in the depressed position, calibrations may be made by turning the adjusting screw.
2. Turn the adjusting screw until the brake shoes are tight against the brake drum (brake chamber push rod in the released position).
3. Back off the adjusting screw two notches on the front units and three notches on the rear units.
4. When all adjustments have been completed, ensure that the locking sleeve is returned to a locked position by permitting it to engage the hexagon head of the adjusting screw.

CAUTION: All the slack adjusters on the coach must be at the same angle.

REMOVAL AND INSTALLATION

1. To remove a slack adjuster, remove the brake chamber push rod yoke pin, capscrew, and the snap ring which holds the slack adjuster onto the brake camshaft.
2. Slide the slack adjuster off the spline end of the camshaft.
3. When installing a slack adjuster, clearance must be allowed to ensure that the slack adjusters can be rotated to the maximum stroke of the brake chamber. Install the grease fitting and locate the slack adjuster on the camshaft in such a manner as to allow both the adjuster screw and grease fitting easy access when servicing.
4. Install the retaining ring onto the end of the slack adjuster in order to hold the slack adjuster in place.

Refer to Operating Test to ensure that proper adjustments are made to provide for these conditions when installing the slack adjuster.

OPERATING TEST

1. Apply the coach brakes and inspect to ensure that the slack adjusters rotate freely and without binding.
2. Release the brakes and check to be sure that slack adjusters return to a released position freely without binding.

AUTOMATIC SLACK ADJUSTERS (OPTIONAL)

Automatic slack adjusters are designed to resist wear and to function for longer periods on coaches under severe service conditions. Because of the slack adjuster's importance, the coach comes from the factory with the cover plates welded in place. This ensures that no tampering is done with the internal components of the adjuster. See figures 4-36.

The automatic slack adjuster consists of a worm shaft and wheel combined with an adjusting mechanism. The worm wheel is attached to the brake camshaft.

MC-9 MAINTENANCE MANUAL

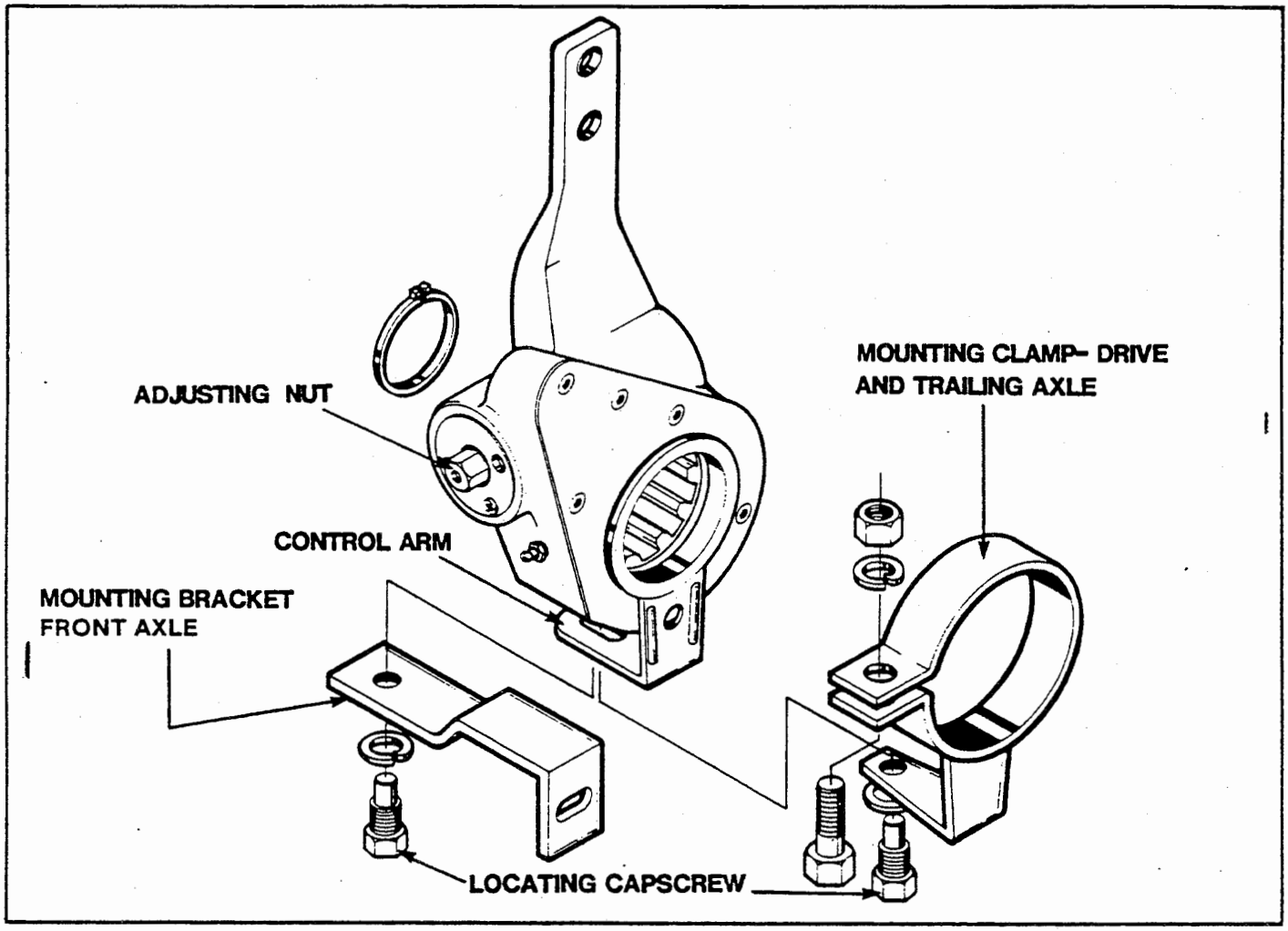


Figure 4-36. Optional Automatic Slack Adjuster.

The rack and pinion linkage produces rotation of the worm shaft through a clutch, only during the running clearance portion of the adjuster travel on the return stroke. During that portion of travel when "lining-drum" contact exists, the transmitted force disengages the shaft from the linkage and stops the shaft from further rotation.

Each time the brake is applied and released, the adjusting mechanism compares the point in the stroke where the space is taken up with the point where the shaft engages the linkage. When lining wear increases the "lining-drum" clearance, the shaft and clutch are engaged for a portion of a stroke and an adjustment is made by a rotation of the shaft and wheel on the return stroke. Adjustment will continue on each brake application until the drum contact space taken up occurs at the same point. At this point, the mechanism will stop adjusting and maintain a running clearance until lining wear increases the clearance.

The slack adjuster is equipped with a hex nut on the worm shaft for manual adjustment at time of installation or brake servicing.

NOTE: On the Haldex (SAB) slack adjusters, the nut on the earlier models is 12 mm. Later models have 7/16" nut which is identified by notches on the circumference of the nut.

REMOVAL

1. Remove the brake chamber push-yoke pin, capscrew, and the washer which holds the slack adjuster on the brake camshaft. (Other methods of affixing the adjuster to the brake camshaft may also be used; however, the capscrew method is the most common.)
2. Slide the slack adjuster off the spline end of the camshaft.
3. If the slack adjuster does not slide off the camshaft easily, a puller tool may be used. Apply the puller to the body or the outer edge of the welded cover only, using a flat block to protect the slack adjuster.

CAUTION: Do not pry on the control arm assembly or directly on the cover.

INSPECTION

Every two months or 25,000 miles (40,000 km), inspect all coach slack adjusters.

Check brake chamber stroke by making a low pressure (approximately 20 psi) brake application, and measuring the stroke of the brake chamber push rod. If the stroke does not exceed 1¾" (44.45 mm) measured at 6" to 7" (152.4-177.8 mm) along the adjuster radius, the slack adjuster is operating properly.

Check for looseness in bolts and the anchor bracket and tighten if necessary.

Every 100,000 miles (160,000 km) or once a year, inspect one adjuster to determine if it is able to reduce stroke. Readjust the unit by rotating the hex nut on the worm gear by one-half turn in a counterclockwise direction.

Make a series of full pressure brake applications and observe the rotation of the hex nut during each chamber return stroke. (By leaving the wrench on the hex nut during brake applications, rotation will be easier to observe.) This check may also be made by measuring the brake chamber stroke before and after the brake application. Rotation of the hex nut or reduction of stroke indicates that the adjuster is functioning as required.

If the slack adjuster fails to reduce the brake chamber stroke, perform the same inspection on all coach adjusters and replace those not operating correctly.

LUBRICATION

The coach uses four or six slack adjusters which, although they are not internally serviceable, they do require regular lubrication. Each adjuster should be cleaned (externally) and lubricated every 150 hours or 5,000 miles (8,000 km). Only molybdenum disulphide grease should be used when lubricating slack adjusters.

ADJUSTMENT ON A PRESS

1. Install the slack adjuster into an accurate press and apply approximately 400 lbs. (181 kg) to the hexagonal end of the worm screw.
2. Turn the control arm forcibly clockwise as far as possible. From here, the control arm should not return to its initial position.
3. Slowly increase the pressure on worm screw. At a fixed load of 794 + 33 lbs. (360 + 15 kg), the control arm should move back.
4. If the control arm moves back at a lower or higher load, turn the screw cover clockwise/counterclockwise by means of a spanner wrench.
5. Repeat this procedure until a satisfactory result is achieved.
6. When the adjuster is calibrated correctly, secure the screw cover by means of a light punch in the housing just opposite the notch in the cover.

ADJUSTMENT WITH A SAB TOOL

1. Install the SAB tool in the vice.
2. Install the slack adjuster into the tool with the control arm guided upwards and screw cover pressed against the mechanism of the tool.
3. Turn the cylindrical part of the SAB tool by means of a spanner until the pegs match the holes in the screw cover.
4. Apply a fixed load to the end of worm screw by turning the handle of the tool approximately half a turn. Turn control arm clockwise as far as possible. From here, the control arm should not return to its initial position.
5. If the control arm moves back too early or late, adjust the screw cover by turning the cylindrical part of the tool clockwise/counterclockwise with a spanner wrench.

INSTALLATION

NOTE: The procedure that follows applies to the Haldex (SAB) automatic slack adjusters. The second procedure covers the Rockwell and Bendix-Westinghouse slack adjusters.

1. Check that the brake chamber push rod is in the fully released position.
2. Refer to figure 4-36. As required, install mounting clamp or bracket in position to mount the slack adjuster (tighten the mounting bracket if used but do not tighten the mounting clamp).
3. Fit the slack adjuster on the cam shaft and install the retaining ring.
4. Rotate the adjusting screw clockwise to align the hole in the slack adjuster arm with the hole in the chamber rod clevis.

CAUTION: DO NOT manually push the adjuster into position to align the holes. Use the adjusting nut.

5. Install the clevis pin and retaining pin or clip.
6. Manually rotate the control arm toward the brake chamber until the control arm reaches a positive internal stop.
7. Fix the control arm in this position by installing the locating capscrews, as required, through the mounting clamp or mounting bracket. Tighten the capscrews and tighten the mounting clamp (if used) on the spider boss.

CAUTION: Do not use a hammer or any prying tool to achieve hole alignment. To do so will result in improper adjuster installation or damage.

8. To provide proper initial brake adjustment, rotate the adjusting nut clockwise until brake shoe-to-drum contact occurs. To aid in this determination, spin the wheel.
9. After shoe-to-drum contact, rotate adjusting nut counterclockwise ½ to ¾ turn.

10 Refer to figure 4-37 to confirm the distance measured from the brake chamber to the clevis pin. This measurement must be met by the slack adjusters at both ends of the same axle.

MC-9 MAINTENANCE MANUAL

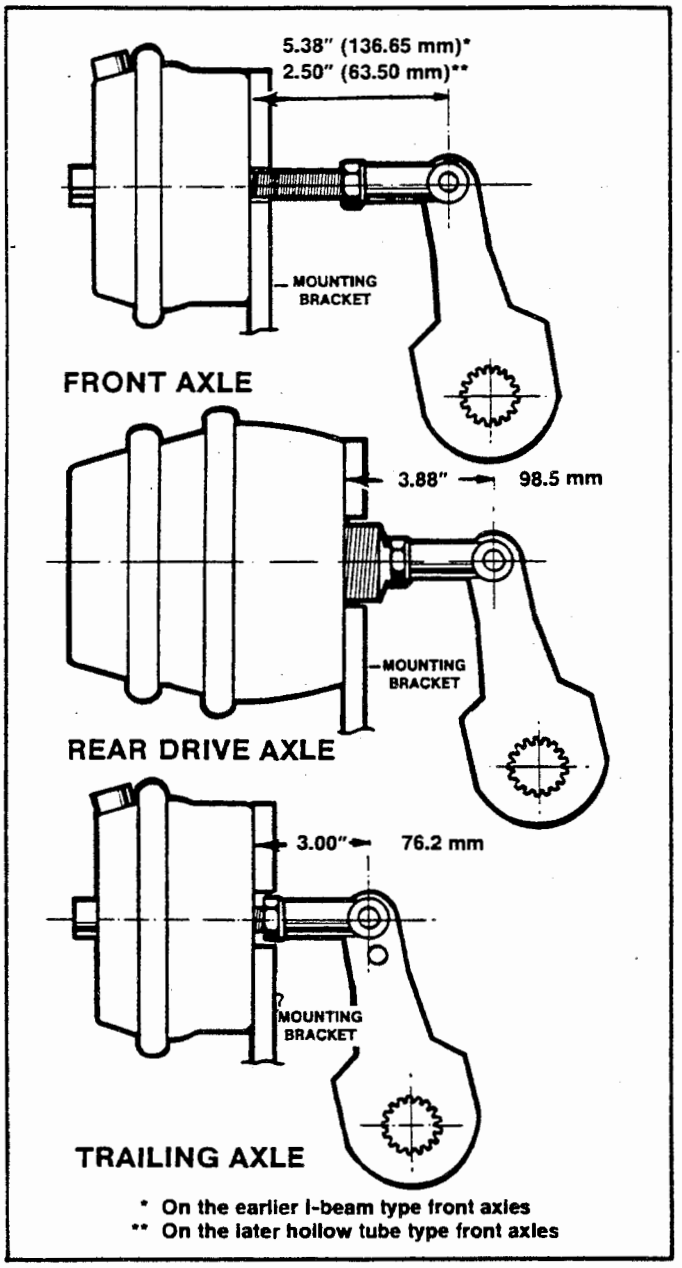


Figure 4-37. Push Rod Adjustment, Automatic and Standard Slack Adjusters.

NOTE: The angle formed by the slack adjuster arm and brake chamber push rod should be 90 to 120 degrees.

11. As a final installation check, remove the clevis pin and manually push the slack adjuster into the clevis pin and release it. Upon return, the adjuster is installed correctly if the adjuster hole and clevis pin hole are in alignment. Secure all fasteners.

NOTE: Step 12 is not necessary if adjuster final check (step 11) was satisfactory.

12. If holes do not align (step 11), place clevis pin through holes. Loosen the control arm fasteners and move the control arm toward the brake chamber until it comes to a definite stop. Tighten the bracket fasteners and repeat step 11.

BRAKES

The brakes used on the coach are heavy duty, double-shoe. Shoes are mounted with individual anchor pins on open-type spiders. The brakes are actuated by "S" type, constant lift cams which are forged integral with the shaft and mounted in needle bearings. Cam pressure is applied through roller cam followers attached to the brake shoes.

MAINTENANCE

A schedule for the periodic adjustment, cleaning, inspection, and lubrication of brake equipment should be established by the operator on the basis of parts particularly subject to wear. To compensate for this wear, brakes should be adjusted as frequently as required to maintain satisfactory operation and maximum safety. Adjustments should provide uniform lining clearance, correct travel of levers and proper equalization.

Brakes should be cleaned, inspected, lubricated and adjusted each time the hubs are removed.

Machining of brake drums is permitted under the following guideline.

Original Diameter	14.50" (368.3 mm)
Max. Allowable Wear	14.812" (376.2 mm)

Under no circumstances should brake drums be used if they have been machined to a greater dimension than allowed (14.812" -376.2 mm).

WARNING: When refaced drums and oversize linings are used, precautions regarding cam travel should be observed to prevent sticking cams or cam "roll over." This condition may occur when linings become worn beyond allowable limits. Service instructions relative to the use of oversize roller cam followers must be carefully followed. Drums which have been refaced should be installed on coaches operating under the least severe conditions.

Linings vary considerably in size and content. They should be replaced only with linings available in the Parts Manual.

DISASSEMBLY

Brake parts are shown in figures 4-38, 39 and 40.

1. Remove the wheels as outlined in Section 15.
2. Remove the shoe return spring. Remove lock rings, retainers, and felts from anchor pins
3. Cut lock wire and remove anchor pin lock screws.
4. Remove anchor pins and shoe assemblies.
5. Loosen Allen screws and remove roller cam followers and pins. Remove slack adjuster.
6. Remove lock ring or loosen lock screw in spacer and remove camshaft.
7. Wire the spacers to the brake spider.
8. Remove washer and felts from cam shaft and spider.
9. Remove bushings from shoe of bearings and from spider as required.

MC-9 MAINTENANCE MANUAL

REPAIR

During major overhaul, the following parts should be carefully checked and, if necessary, replaced with genuine replacement parts as required:

1. Backing plates for distortion, and backing plates and spiders for looseness or sheared rivets.
2. Anchor pins for wear plates or angles faces.
3. Cam shaft and cam shaft bearings or bushings for wear or brinelling.
4. Shoe return springs should be replaced at the time of overhaul.
5. Brake linings for grease saturation, wear, and loose rivets or bolts.
6. Drums for cracks, scoring, or other damage.

Prior to reassembling, the following parts should be lightly coated with lubricant:

1. Anchor pins at abutment block or shoe surface.
2. Adjustable anchor pin bearing surface.
3. Cam shaft bearings or bushings.
4. Cam roller followers and wear plates.

REASSEMBLY

1. Install new bushings in brake shoes if required. New bushings must be line reamed to size before assembling shoes.
2. Install new bearings in brake spider as required.
3. Install roller cam followers and pins. Tighten Allen lock screws securely.

WARNING: When brake drums have been refaced and oversize linings installed, the following repair parts must be used to prevent sticking cams and/or cam "roll-over" and brake failure:

A. Install large washers, felt and washer on cam end of shaft.

B. Install washers, felt retainers and spacers when inserting camshaft through spider and bracket.

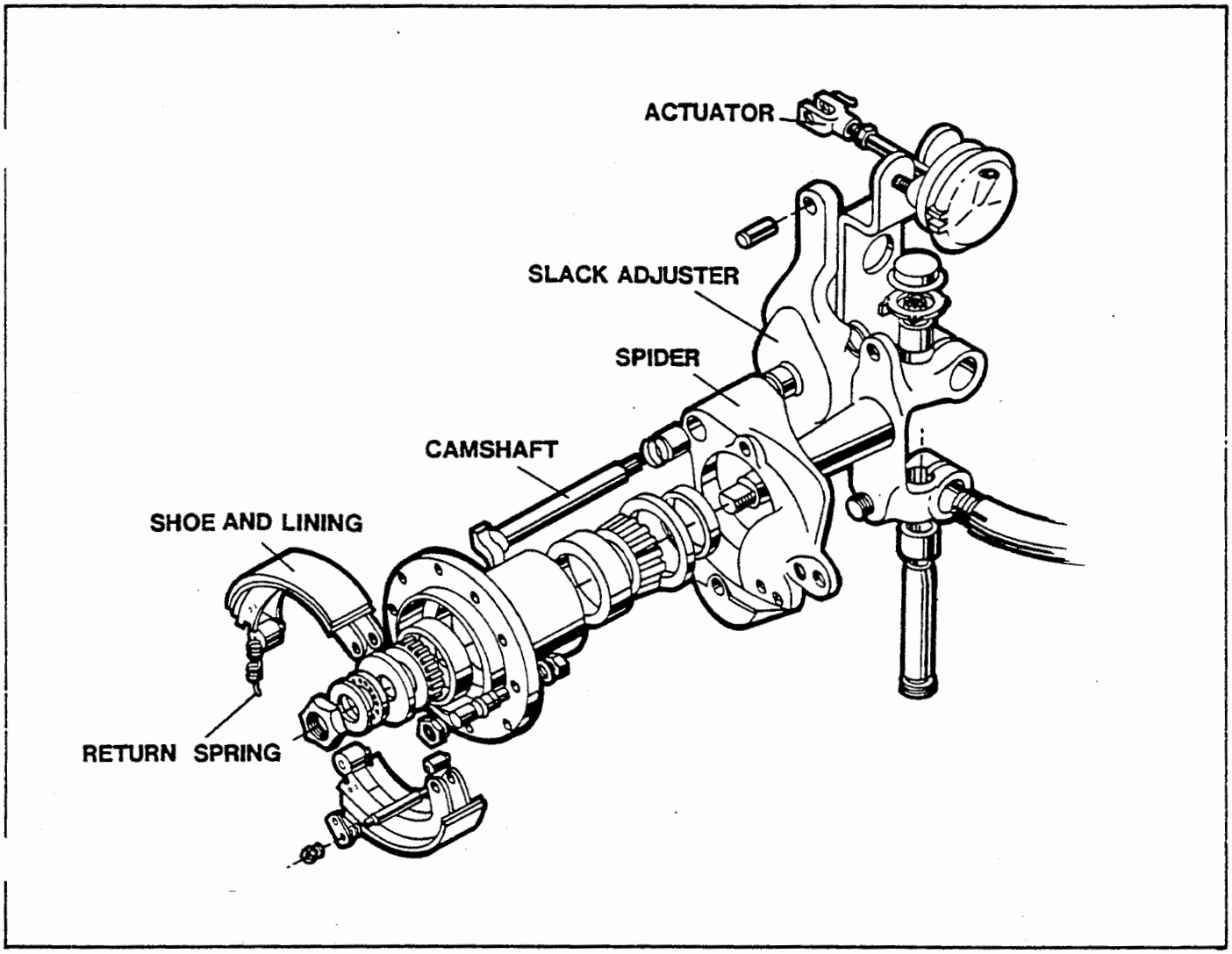


Figure 4-38. Front Brakes.

MC-9 MAINTENANCE MANUAL

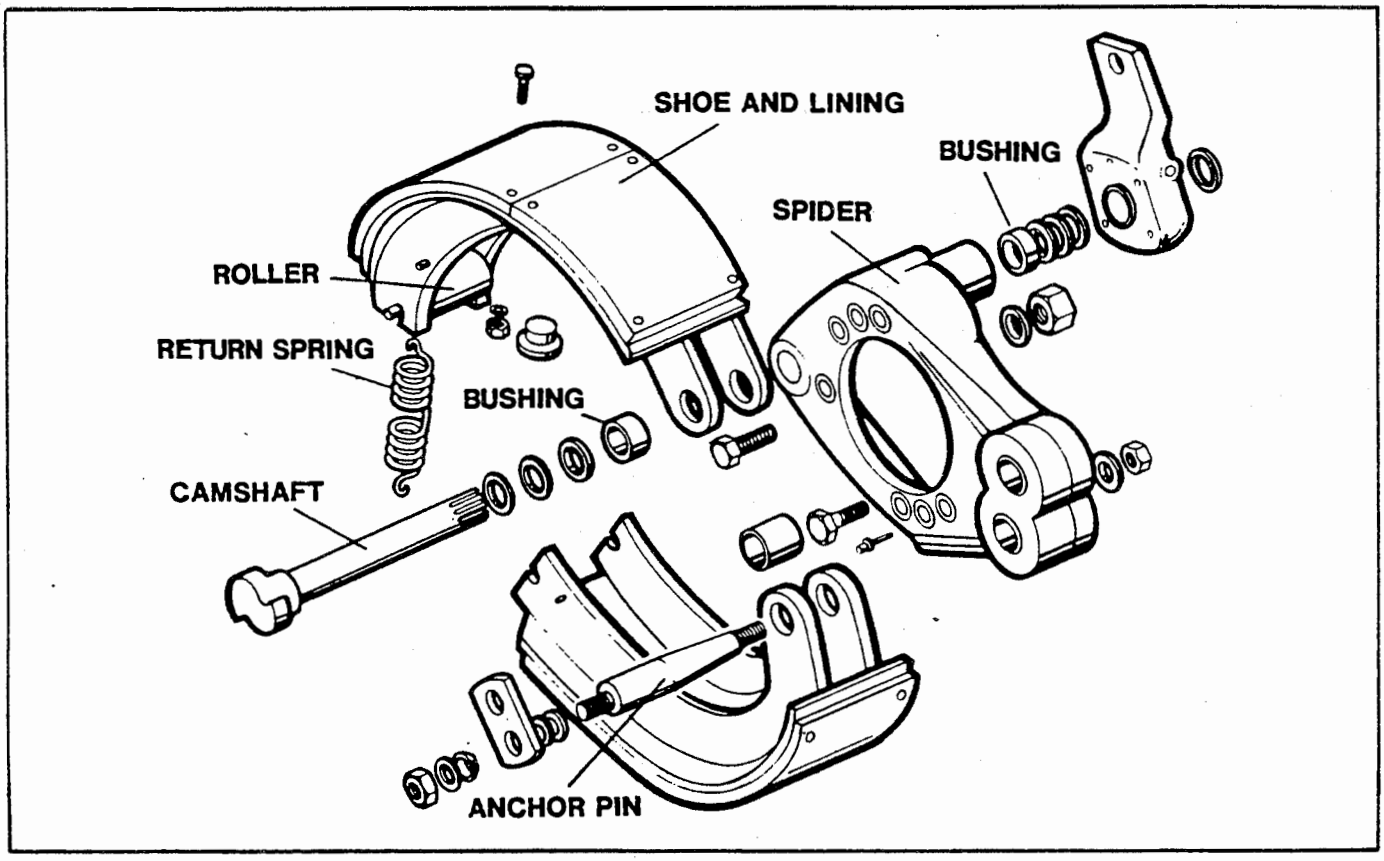


Figure 4-39. Drive Axle Brakes.

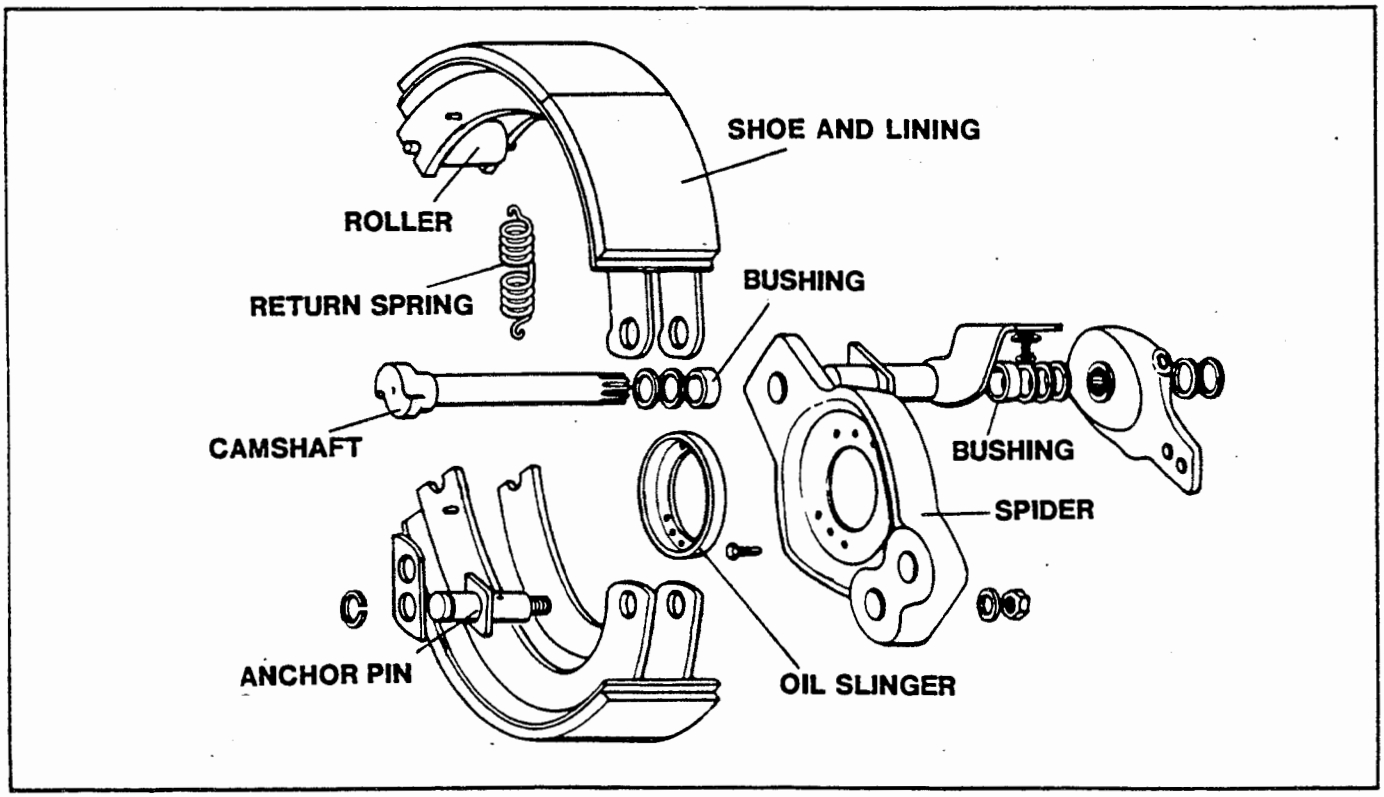


Figure 4-40. Trailing Axle Brake.

4. Install lock ring or tighten set screw in spacer. Position brake shoe over spider and tap anchor pin into position with "flat" in line with lock screw hole. Repeat with opposite shoe assembly.

5. Install lock screws, tighten securely and thread with lockwire.

6. Position felts, retainers and install lock rings.

7. Install shoe return spring. Install slack adjuster on splined end of cam shaft and adjust as required.

8. Assemble snap rings using washers to take up end play if necessary.

ADJUSTMENT

New linings should be circle ground and adjusted to a few thousandths less than drum diameter. Install slack adjuster on splined end of cam shaft and adjust as required. See Slack Adjusters in this section.

AIR HORNS AND VALVE (OPTIONAL)

The purpose of the air horns is to provide a warning signal of greater volume and carrying qualities than usually found on automotive vehicles. The horns are designed on the principle of a vibrating diaphragm; they consist of die cast bodies, diaphragms, and two black painted horn bells, with the bells in a horizontal position.

The horns are operated by pushing down on the button of the foot-operated horn valve. This action pushes down on the supply valve stem in the horn valve and opens the supply valve.

When air enters the cavity in each air horn on one side of the diaphragm, pressure builds up on the diaphragm, deflects it, and the air escapes through the horn bells. This action sets up a vibration of the diaphragm in each horn bell.

The two different lengths of horn bells give the horn its dual tone. The vibrations are set up in an air column denser than atmosphere, due to escaping compressed air, which provides unusual tone carrying qualities.

MAINTENANCE AND TESTING

Every 10,000 miles (16,000 km), remove the strainer in the bottom of horn valve and clean thoroughly with cleaning solvent. Remove dirt screens in the horn bells and clean. Refer to figure 4-43.

Every 50,000 miles (80,000 km), disassemble the air horn and clean all parts. Disassemble the air horn valve and clean all parts.

Operating Test: With air pressure in the system, operate the horn valve and the horn should give a load, clear dual tone horn blast.

Leakage Test: With the horn valve in the released position, leakage at the delivery port or at the valve stem at the top of the horn valve should not exceed a one-inch (25.4 mm) soap bubble in one second. With the horn valve applied, leakage at the stem at the top of the horn valve should not exceed a one-inch (25.4 mm) soap bubble in one second.

REMOVAL AND DISASSEMBLY

AIR HORN

1 Disconnect the air line to the air horn. Remove air horn mounting nut and remove horn. Refer to Figure 4-41.

2. Remove the eight nuts and bolts holding the two covers to the body.

3. Remove the diaphragms from the body of the air horn.

4. Remove the spring contact, springs, and the spring assemblies from the covers of the air horn.

5. Remove the horn bells from the body.

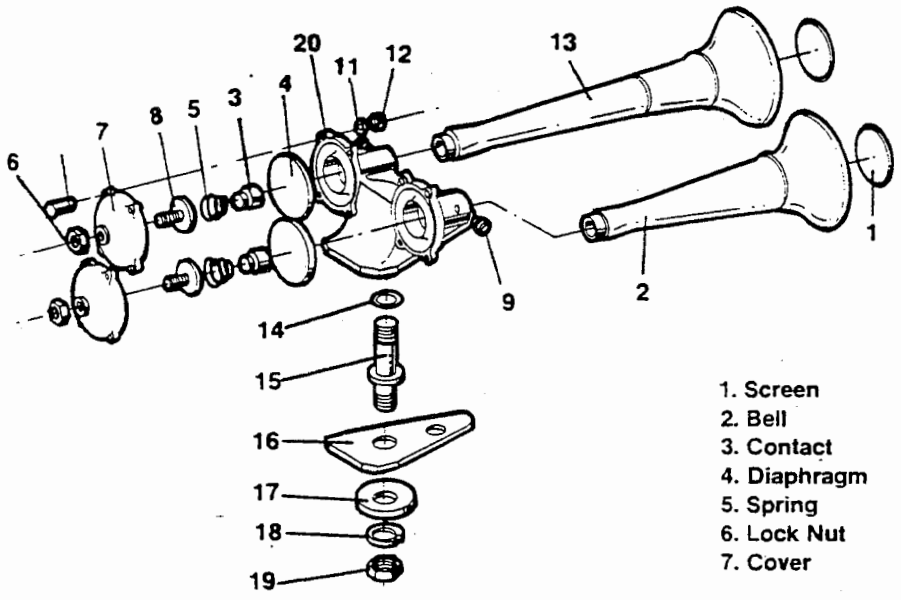
HORN VALVE

1. Vent the air system. Disconnect air lines to the horn valve. Remove mounting bolts and remove the horn valve. Refer to figure 4-42.

2. Remove the spring seat from the valve body.

3. Remove the valve stem from the valve body.

4. Remove the strainer and spring from the spring seat.



1. Screen
2. Bell
3. Contact
4. Diaphragm
5. Spring
6. Lock Nut
7. Cover
8. Seat-Spring
9. Set Screw
10. Screw
11. Washer
12. Nut
13. Bell
14. O-ring
15. Coupling
16. Gasket
17. Washer
18. Washer
19. Nut
20. Body

Figure 4-41. Air Horns.

MC-9 MAINTENANCE MANUAL

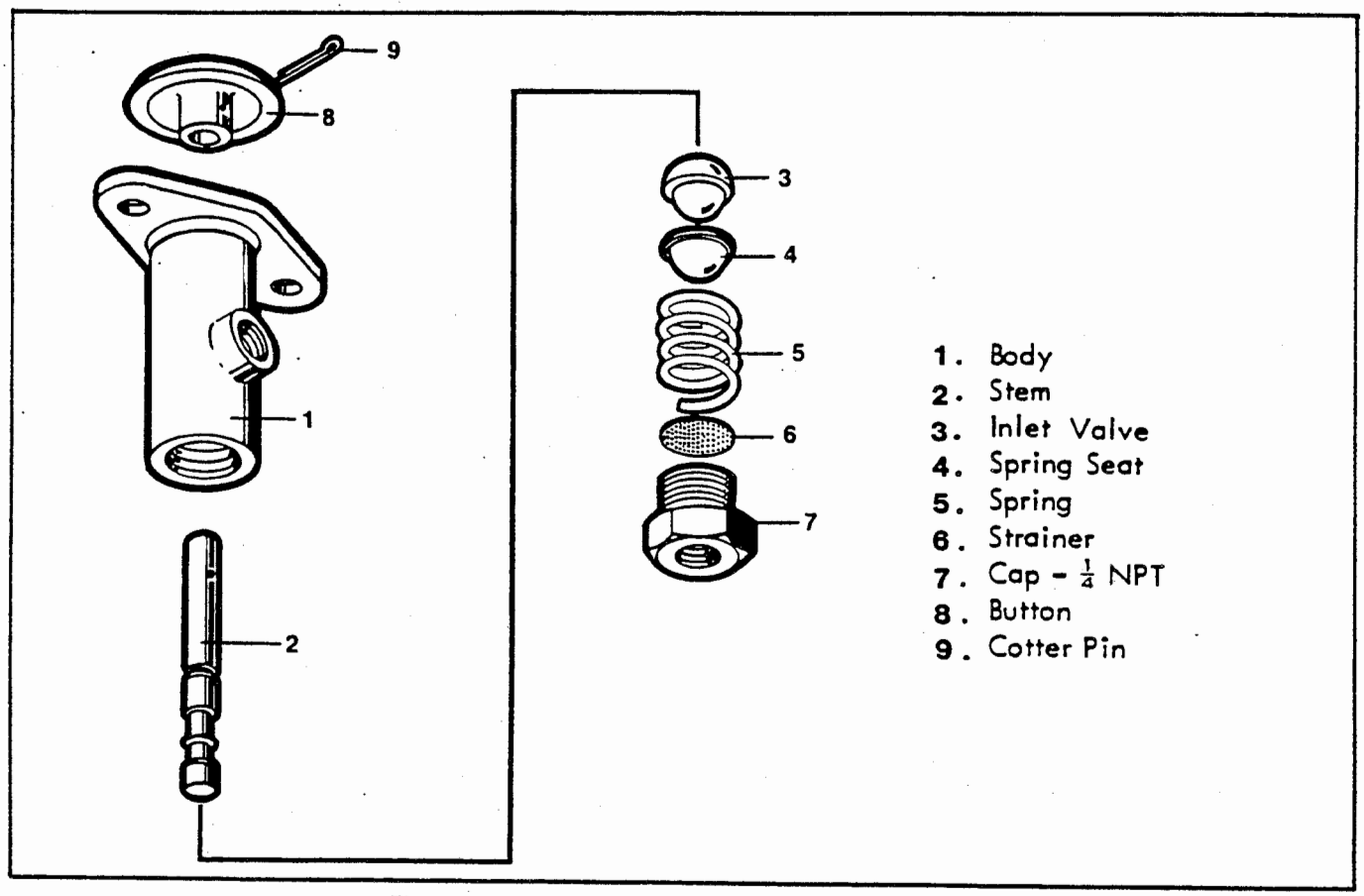


Figure 4-42. Air Horn Valve.

INSPECTION

1. Inspect air horn supply valve and seat. If damaged, they should be repaired or replaced.

2. Wash all air horn metal parts in cleaning solvent.

3. Carefully inspect the diaphragms to be sure they are not cracked, deteriorated, or distorted in any way. If ridges or cracks are found, the diaphragms must be replaced.

4. Inspect condition of the body. Be sure diaphragm seat in body is not chipped or damaged in any way. Check for cracks in the body and replace as necessary.

5. Inspect the covers. Be sure diaphragm seat in cover is not chipped or damaged. Inspect the cover for cracks.

6. Inspect the horn bells. If they are cracked or broken, they should be replaced.

7. Inspect the spring contacts. Replace if distorted or deteriorated.

8. Check the spring; if broken, replace.

AD-2 AIR DRYER
Prior to Unit 41089

The AD-2 air dryer is installed at the front of the front bogie in the main air line between the compressor and the wet air tank. See figure 4-43. The purpose of the air filter dryer is to remove water and oil vapor from the air system, by means of condensation and a desiccant. This provides longer component life and helps prevent freeze-up. The system is self purging during the unloading cycle of the air compressor.

The housing assembly consists of two cylindrical steel stampings welded together. A safety valve is mounted in the lower housing assembly protecting against excessive pressure within the housing. Refer to figure 4-44.

The desiccant sealing plate assembly is located midway in the assembly and houses a replaceable ball-type single check valve. Also located in the plate assembly is the purge orifice.

The desiccant cartridge and the pleated paper oil filter are removable and comprise a complete, serviceable unit.

The desiccant, which is referred to as the "drying bed," is a drying substance that has the unique property of exposing a tremendous surface area in proportion to its bulk. One pound of desiccant beads has about two million square feet of adsorptive area made up of a large number of microscopic cavities in each bead. Each desiccant bead adsorbs or collects moisture.

The desiccant is held in place by steel perforated plates and filter cloths. The top plate is held in place by a spring and the bottom plate rests on a shoulder approximately ⅛" (3.1 mm) from the bottom of the cartridge housing.

The end cover assembly is retained by a lock ring, capscrews and retainers and houses the purge valve and heater assembly.

The heater and thermostat assembly prevent freeze-up in the purge drain valve when the dryer is used in severe winter conditions.

The 120 watt, 24 volt DC heater and thermostat assembly has an operating range between 50°F - 85°F (10°C - 29°C).

NOTE: The heater and thermostat assembly provided with the dryer has a 3/16" (4.7 mm) diameter threaded electrical terminal protected by a boot. It is nonserviceable.

MC-9 MAINTENANCE MANUAL

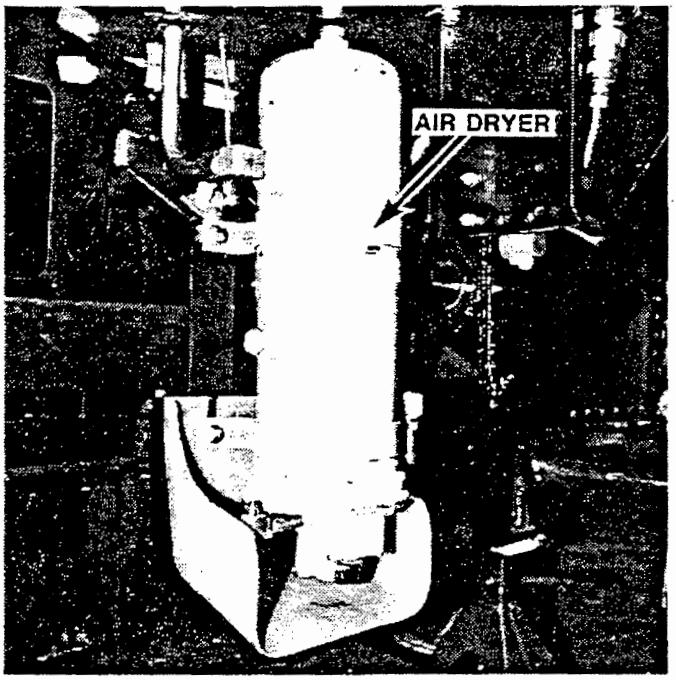


Figure 4-43. Air Dryer Installed.

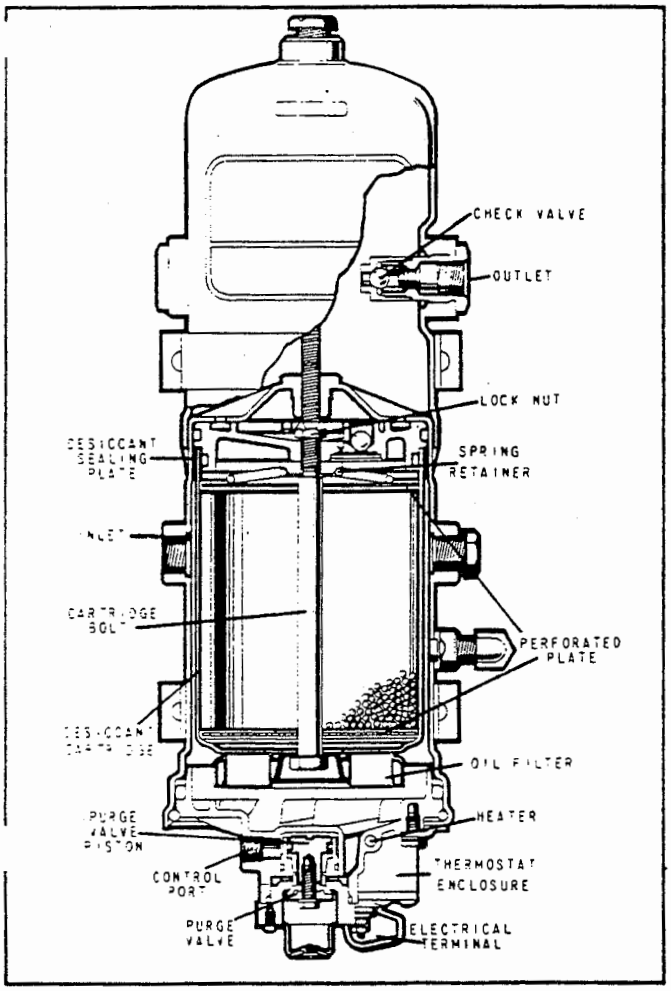


Figure 4-44. Air Dryer Cross-Section.

OPERATION

The operation of the AD-2 dryer can be best described by separating the operation into two cycles: the charge cycle and the purge cycle.

CHARGE CYCLE — With the compressor in its "loaded" or compressing cycle, air from the compressor enters the air dryer through the discharge line. When the air, along with the water and other contaminants, enter the air dryer, the velocity of the air reduces substantially and much of the entrained liquid drops to the bottom of the air dryer. The initial air flow is toward the bottom of the dryer, but air flow direction changes 180° at the bottom of the air dryer, dropping some water and oil.

The air now passes through the oil filter which removes some oil and foreign material but does not remove water vapor. At this point, the air remains saturated with water.

The filtered air and vapors penetrate the desiccant drying bed and the absorption process begins. Water vapor is removed from the air by the desiccant.

The unsaturated "dry air" passes through the ball check valve and purge orifice into the purge volume. From the purge volume air flows through a check valve and into the air reservoir.

PURGE CYCLE — When desired air system pressure is reached, the governor cuts out (115-118 psi/793-814 kPa), pressurizing the unloader cavity of the compressor which unloads the compressor. The line connecting the governor unloader port to the end cover purge valve port (bottom of the air dryer) is also pressurized, opening the exhaust of the purge valve to atmosphere. With the exhaust of the purge valve open, contaminants in the discharge line and dryer sump are purged, or forced past the open exhaust out to atmosphere.

The reverse air flow across the desiccant starts the removal process of moisture from the desiccant surface. Dry air flowing from the purge volume through the purge orifice and across the drying bed further dries the desiccant.

The combination of these reverse flows strips the water vapor from the desiccant (drying bed). This normally takes 12-15 seconds.

The desiccant becomes re-activated from this cycle and is now ready for another charge cycle, which occurs when the compressor returns to the compressing cycle.

MAINTENANCE

The desiccant cartridge should be replaced or rebuilt when the desiccant is contaminated and does not have adequate water adsorption capacity. However, the following checks should be made before replacing the desiccant cartridge to ascertain that the water accumulation is not related to the below listed conditions.

A. An outside air source has been used to charge the system. This air did not pass through the drying bed.

B. Air usage is exceptionally high and not normal for the coach. This may be due to accessory air demands or some unusual air requirement that does not allow the compressor to load and unload (compressing and non-compressing cycle) in a normal fashion. Check for high air system leakage.

C. The air dryer has been installed in a system that has been previously used without an air dryer. This sytem will be saturated with moisture and several weeks of operation may be required to dry it out.

Every 25,000 miles (40,000 km) or every three months, perform the following maintenance procedure:

1. Check for moisture in the brake air system by draining air reservoirs and checking for presence of water.

NOTE: In areas where more than approximately a 30° F (17°C) range of temperature is common, small amounts of water can accumulate in the air brake system due to condensation. The presence of small amounts of water is normal.

2. Check mounting bolts for tightness. Check all air and electrical connections.

3. Check the operation of the integral single check valve in the air dryer. Build the air system to governor cut-out (115-118 psi/793-814 kPa) and observe the test air gauge installed in the wet air tank reservoir. A rapid loss of pressure could indicate a failed check valve. This can be confirmed by checking at the purge valve exhaust.

NOTE: Purge valve will be open when governor cut-out (115-118 psi/793-814 kPa) pressure is reached. Allow two minutes for purge cycle before testing the check valve.

4. Check for excessive leakage at the purge valve by coating the exhaust with a soap solution while the compressor is loaded (compressing air).

5. Check the operation of the safety valve by pulling the exposed stem while the compressor is loaded (compressing air). There must be an exhaust of air while the stem is held and the valve should reseat when the stem is released.

6. Check all air lines and fittings leading to and from the air dryer for leakage and integrity.

7. Check the operation of the heater and thermostat during cold weather operation. This can be done by allowing the end cover assembly to cool below 50°F (10°C) and feeling the end cover when the ignition is turned on. The end cover should be warm to the touch within a few moments. Warming should cease at about 85°F (29°C).

The desiccant change interval may vary; however, it is generally recommended that the desiccant be replaced every 12 months. If experience has shown that extended or shortened life has resulted for a particular installation, the interval can be increased or reduced accordingly.

REPLACING OR REBUILDING AIR DRYER

If, after completing the routine serviceability tests, one or more components of the air dryer requires replacement or maintenance, refer to the following kits for replacement parts.

A. TMC/MCI Part No. 4R-19-77: DESICCANT CARTRIDGE REFILL KIT — This kit can be used for the Type AD-2 air dryer. This kit consists of necessary parts to rebuild the cartridge and purge plate.

B. TMC/MCI Part No. 4R-19-76: DESICCANT CARTRIDGE REPLACEMENT KIT — This kit contains a factory replacement desiccant cartridge and the parts necessary to rebuild the desiccant sealing plate.

C. TMC/MCI Part No. 4R-19-78: PURGE VALVE MAINTENANCE KIT — This kit contains the parts necessary to rebuild air dryer end cover purge valve.

D. TMC/MCI Part No. 4R-19-79: CHECK VALVE MAINTENANCE KIT — This kit contains the components necessary to rebuild the integral check valve in the outlet port of the air dryer.

REMOVAL OF DESICCANT CARTRIDGE

NOTE: Air dryer parts diagram (figure 4-55) is found at end of section, before Troubleshooting.

1. Make certain the vehicle is safely parked. Block the wheels if necessary.

2. Vent the air system completely, being sure that the lines leading into and out of the air dryer are at atmospheric pressure.

3. Disconnect the air line from the end cover and mark location of this port on the air dryer.

4. Disconnect the heater wire.

5. Loosen the three capscrews on the end cover and turn the retaining clamps aside (capscrews may be left finger tight).

6. Locate the notch in the air dryer shell. While pushing the end cover up into the dryer, insert the blade of a screwdriver in the notch and slowly pry out the retaining ring. Remove the end cover assembly and set it aside temporarily.

7. Using a ¾" socket wrench, remove the cartridge and desiccant sealing plate assembly.

NOTE: Be certain the desiccant sealing plate assembly comes out with the cartridge.

REMOVING AND REBUILDING DESICCANT SEALING PLATE

Before the desiccant cartridge can be replaced or rebuilt the desiccant sealing plate must be removed. All non-metallic parts should be replaced when the plate is removed. Removing the single hex lock nut will permit the desiccant plate to be separated from the desiccant cartridge. After removing the desiccant cartridge:

1. Remove the two O-rings from the desiccant plate and discard them.

2. Remove the ball check valve retaining clip and remove and discard the rubber ball valve.

3. Clean the desiccant plate thoroughly using commercial solvent, making sure the purge orifice and check valve seat are clean.

4. Install a new ball check valve and replace the retaining clip and screw. See figure 4-45.



Figure 4-45. Installing Check Valve.

5. Thoroughly lubricate the two new O-rings and install them in their respective grooves in the purge plate (figure 4-46).

6. Set the desiccant sealing plate aside for reinstallation on the desiccant cartridge.

REPLACING DESICCANT CARTRIDGE

Prior to installing the new replacement cartridge in the air dryer, the following steps must be followed.

1. Carefully remove the lock nut from the cartridge bolt using an 11/16" open end or box wrench.

CAUTION: Care must be taken not to allow the cartridge bolt to slip out the cartridge when the lock nut is removed. Loss of desiccant material will occur should this happen.

2. Install the previously rebuilt desiccant sealing plate on the cartridge bolt so that the ball check retaining clip remains visible.

3. While holding the cartridge bolt, reinstall the lock nut on the cartridge bolt.

CAUTION: Before tightening the lock nut make certain that the shoulder (the unthreaded portion) of the cartridge bolt extends slightly above the perforated desiccant plate.

4. By tightening the lock nut, draw the desiccant sealing plate down in to the desiccant cartridge until the shoulder of the desiccant sealing plate is against the cartridge shell.

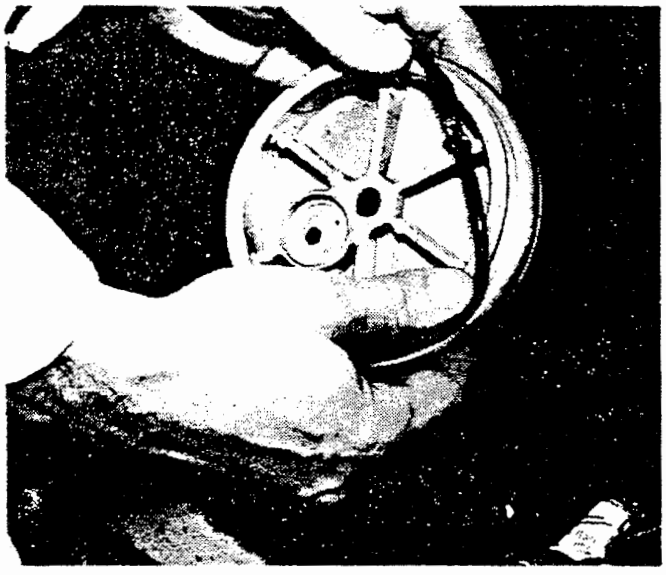


Figure 4-46. Installing O-Rings On End Cover.

REBUILDING THE DESICCANT CARTRIDGE

The desiccant cartridges are identified by the Bendix trademark BW stamped in the hex head of the cartridge bolt, and by the letters and number AD-2 displayed on the bottom face of the oil filter.

1. Refer to figure 4-47. Carefully remove the lock nut on top of the desiccant sealing plate. (The plate is spring loaded; however, the spring load is completely relieved when the nut is removed.)



Figure 4-47. Desiccant Cartridge.

2. Remove the desiccant sealing plate and rebuild it as outlined under Removing and Rebuilding the Desiccant Sealing Plate.

3. Remove and retain the spring, spring seat, bolt and cartridge shell. Discard the oil separator filter, the two perforated plates and desiccant material.

4. Insert one of the perforated plates into the cartridge, felt cloth up, and tap it firmly to the bottom. (Felt always faces desiccant material.) See figure 4-48.

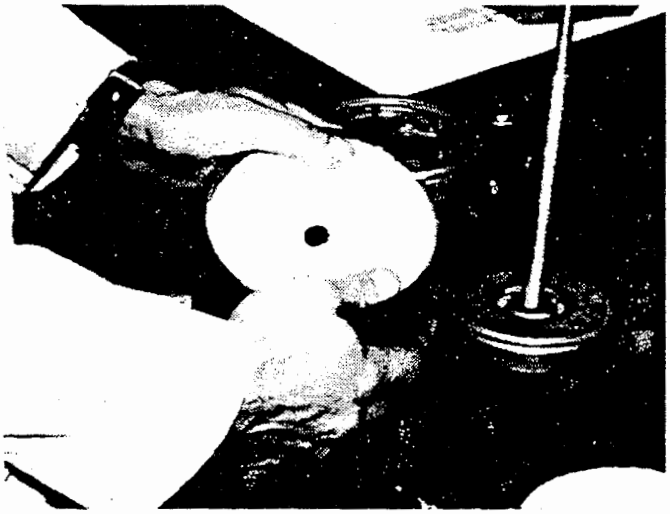


Figure 4-48. Inserting Felt Plate.

MC-9 MAINTENANCE MANUAL

5. Slide oil filter separator over the cartridge bolt with the gasket surface next to the shell, figure 4-49.

6. Install the bolt with the oil separator into the bottom of the shell and through center hole of the perforated plate in the bottom of the shell. See figure 4-50.

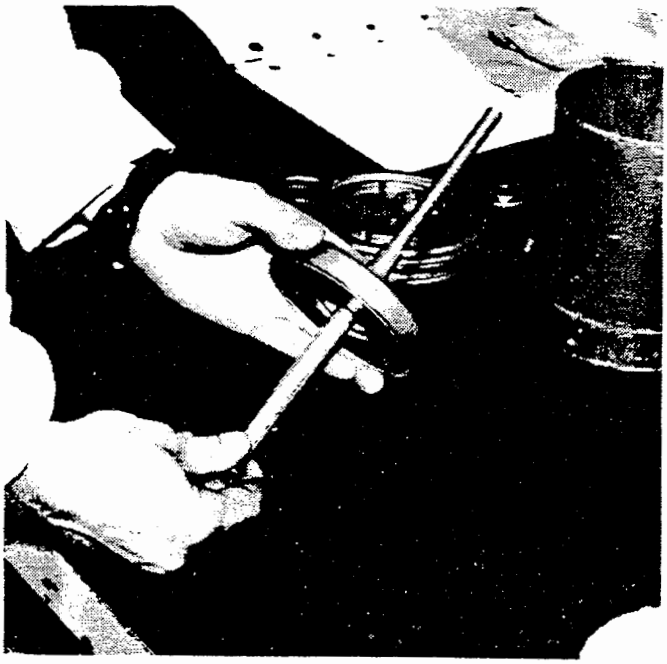


Figure 4-49. Oil Filter Separator Installation.



Figure 4-50. Installing Bolt With Separator Into Shell.

7. Pour the entire package of desiccant material into the shell, making sure none is lost. Handle carefully so that the bolt does not fall out. Refer to figure 4-51.

8. Level the desiccant material and install second perforated plate felt cloth down. (Make sure the shoulder of the bolt is centered and extends slightly above the top of the perforated plate.) See figure 4-52.

NOTE: If the shoulder of the bolt does not extend above the perforated plate, tap the side of the desiccant container.



Figure 4-51. Pouring Desiccant Into Shell.

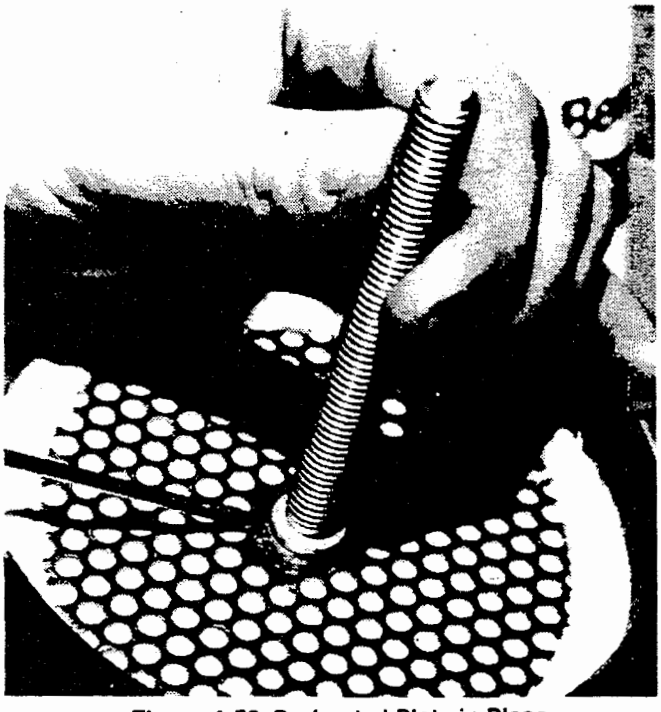


Figure 4-52. Perforated Plate in Place.

9. Set the conical spring on top of the perforated plate. (Large diameter down - small diameter up.)

10. Place the spring retainer on top of the spring (figure 4-53).

12. Using the lock nut, draw the assembly together to approximately half of the spring's free height. While slowly turning the cartridge, tap the side of the shell with a plastic mallet (figure 4-54). This allows the desiccant material to settle properly into place. Continue to tighten the nut, making sure all items are properly aligned. Tighten nut firmly using an 11/16" socket or box wrench.

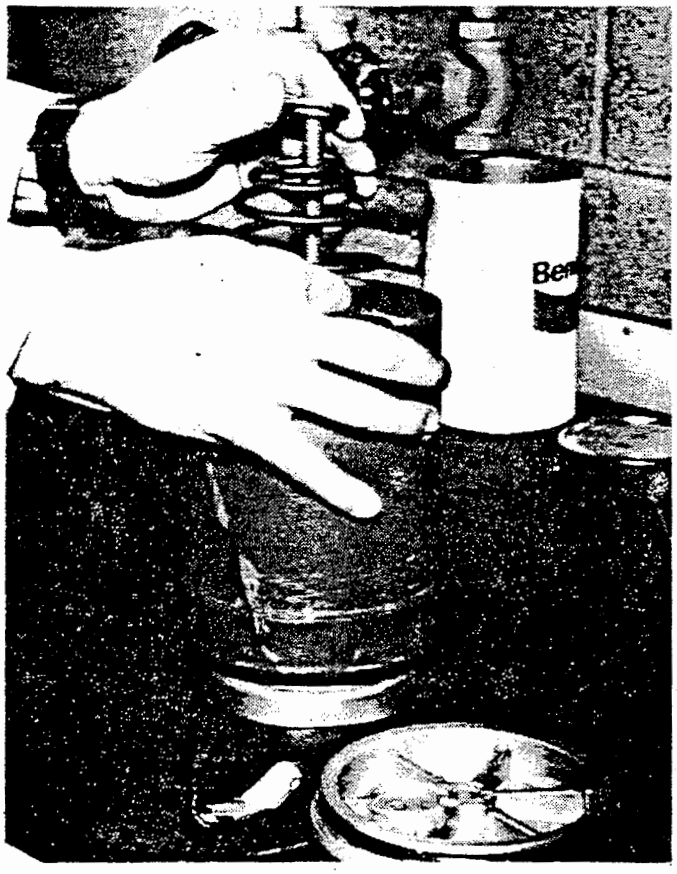


Figure 4-53. Installing Spring and Spring Retainer.

REBUILDING END COVER ASSEMBLY

To remove the end cover assembly from the air dryer, follow steps 1-6 under the section entitled Removal of Desiccant Cartridge. Before rebuilding the end cover, clean the exterior thoroughly using commercial solvent.

DISASSEMBLY OF END COVER ASSEMBLY.

1. Remove and discard the large O-ring around the end cover assembly.

2. Remove the single No. 6-32 screw securing the exhaust diaphragm and separate the diaphragm, washer and screw. Discard the diaphragm.

3. Remove the three No. 6-32 screws securing the exhaust cover and remove the exhaust cover.

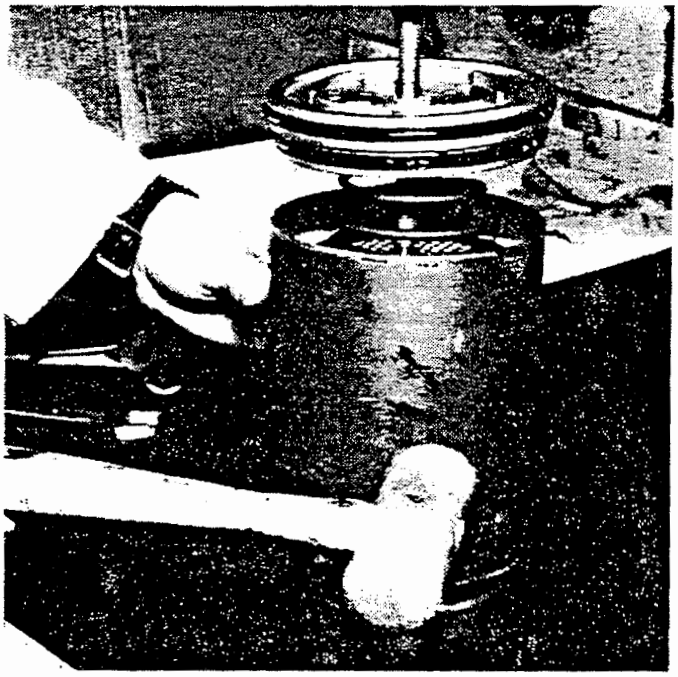


Figure 4-54. Tapping To Settle Desiccant.

4. Remove the purge valve assembly, the large hex cap nut, from the end cover and discard both O-rings around the cap nut.

5. Using a 7/16" socket wrench and a large screwdriver, remove the ¼"-20 hex head capscrew which holds the assembly together.

6. Separate capscrew, purge valve, purge valve piston and the piston return spring.

7. Discard the piston O-ring, the purge valve, and the piston return spring. Wash all remaining parts in a commercial solvent, making sure all surfaces, bores, ports and passages are clean and dry before assembly.

REASSEMBLY OF END COVER ASSEMBLY

1. Lubricate the piston O-ring and install it on the piston.
2. Lubricate and install the piston.
3. Install the purge piston return spring and piston.
4. Install the purge valve in the large cap nut so that the rubber portion rests on the metal seat of the capnut.
5. Secure the valve to the piston using the ¼-20 capscrew and lockwasher and torque to 50 inch lbs. (5.6 Nm).
6. Lubricate and install the two capnut O-rings.
7. Lubricate the capnut threads and the capnut bore of the end cover and install the capnut, tightening it to 180-250 inch lbs. (20.3-28.2 Nm) torque.
8. Secure the exhaust diaphragm to the exhaust cover using the No. 6-32 phillips head screw and diaphragm washer.
9. Secure the exhaust cover to the purge valve hex head capnut using No. 6-32 phillips head screws.
10. Lubricate and install the large diameter O-ring around the end cover assembly.

CAUTION: The heater and thermostat assembly in the dryer and cover are non-serviceable. Do not remove the thermostat cover. Should this assembly become defective, the end cover must be replaced.

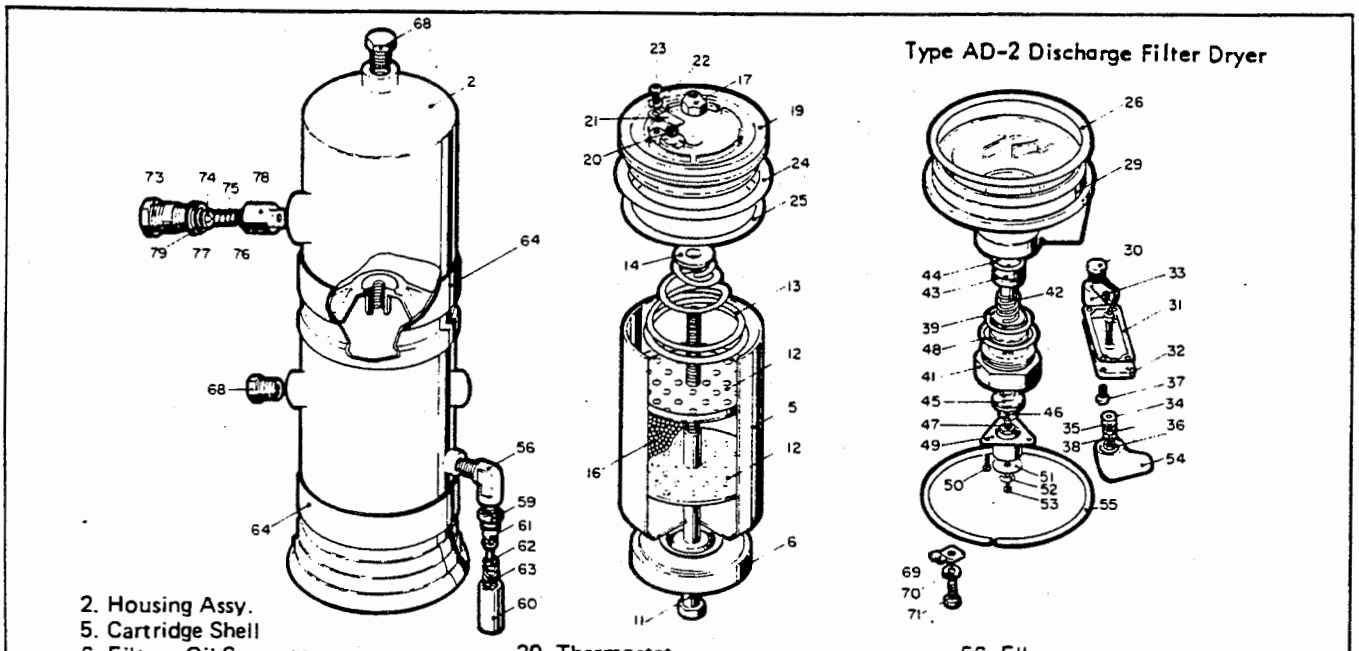
MC-9 MAINTENANCE MANUAL

REBUILDING OUTLET PORT CHECK VALVE

1. Make certain the vehicle is safely parked. Block the wheels if necessary.
2. Locate and remove the line connected to the outlet port.
3. Remove the check valve from the outlet port.
4. Remove the rubber sealing ring from the external threaded portion of the body and discard it.
5. Disassemble the check valve by unscrewing the body halves and note the order of the removal of the parts.
6. Discard and replace the check valve, valve spring and metal seal washer.
7. Wash all parts in commercial solvent making sure all surfaces are clean and dry prior to reassembly.
8. Coat all parts with a film of barium base lubricant.
9. Reassemble the check valve and tighten the body halves to 200-225 inch lbs. (22.5-25.4 Nm) torque.
10. Reinstall the check valve in the outlet port and reconnect the line leading to the wet air tank.

REINSTALLING DESICCANT CARTRIDGE

1. Wipe the inside of the dryer clean. If solvent is used, be certain that no residue is left in the shell.
2. Check to be certain a film of barium grease is present on the O-rings and install the cartridge and purge plate assembly into the body. Engage the bolt and tighten to 375 inch lbs or 32 ft. lbs. (42.3 Nm) torque.
3. Check the end cover O-ring to be certain it is clean; coat with a barium lubricant. Install the O-ring on the end cover and install the end cover in the dryer body.
4. Position the end cover as marked during removal and install the retainer ring so that the gap in the ring is within an inch of the notch in the body.
5. Grease the threads on the three capscrews and reinstall them with their retainers in the end cover.
6. Reconnect the air control line to the purge valve port in the end cover.
7. Reconnect the thermostat and heater wire.
8. Test the air dryer as outlined under Maintenance.



2. Housing Assy.
5. Cartridge Shell
6. Filter Oil Separator
11. Bolt Cartridge
12. Perforated Plate S/A
13. Conical Spring
14. Spring Seat
16. Desiccant
17. Lock Nut - 7/16 - 14 Hex.
19. Plate - Desiccant Sealing
20. Ball Valve
21. Valve Cover
24. O Ring
25. O Ring
26. O Ring End Cover
29. End Cover
30. Thermostat
31. Gasket
32. Cover Thermostat
33. Spacer
34. O Ring
39. O Ring
44. O Ring
48. O Ring
49. Exhaust Cover
50. Screw - 6-32 Thread Forming
51. Diaphragm
52. Washer
53. Screw - 6-32 Thread Forming
55. Retainer Ring
56. Elbow
59. Body
63. Spring
68. Pipe Plug
69. Retaining Clip
70. Lock Washer
71. Cap Screw - 1/4" - 20 Hex. Hd.
73. Body
74. Spring Guide
75. Spring
76. Ball Valve
77. Sealing Washer
78. End Cap
79. O Ring

Figure 4-55. Air Dryer Exploded View.

MC-9 MAINTENANCE MANUAL

AD-4 AIR DRYER
Effective With Unit 41089

The air dryer is mounted on the coach ahead of the front axle on the spare tire compartment bulkhead. The bottom portion of the dryer is protected by a sheet metal shroud. Refer to figure 4-56.

The function of the AD-4 Air Dryer is to collect and remove air system contaminants in solid, liquid and vapor form before they enter the brake system. It provides clean, dry air to the components of the brake system which increases the life of the system and reduces maintenance costs. Daily manual draining of the reservoirs is eliminated.

The AD-4 consists of a die cast aluminum end cover secured to a cylindrical steel outer shell with eight cap screws and nuts. The end cover contains a purge valve mechanism, a safety valve and three threaded air connections.

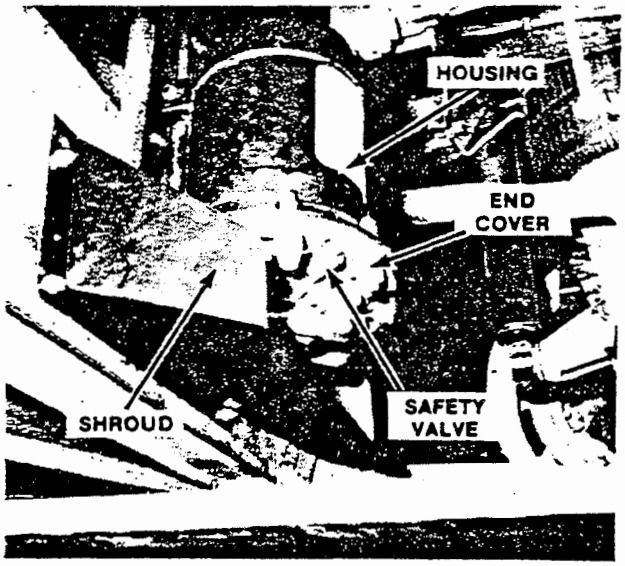


Figure 4-56. AD-4 Air Dryer Installed.

The three air connections on the AD-4 are identified with embossed numbers and lettering. The identification and function of each is as follows:

4 — CON. — Control port (purge valve control)
1 — SUP. — Supply port (air in)
2 — DEL. — Delivery port (air out)

A cast-in heater element and replaceable thermostat with an external electric terminal are provided.

The voltage and wattage requirements of the heater and thermostat are shown with embossed numbers and letters in the recess adjacent to the control port marked CON.

OPERATION

Operation of the air dryer can most easily be understood if it is separated into two cycles — the CHARGE cycle and the PURGE cycle.

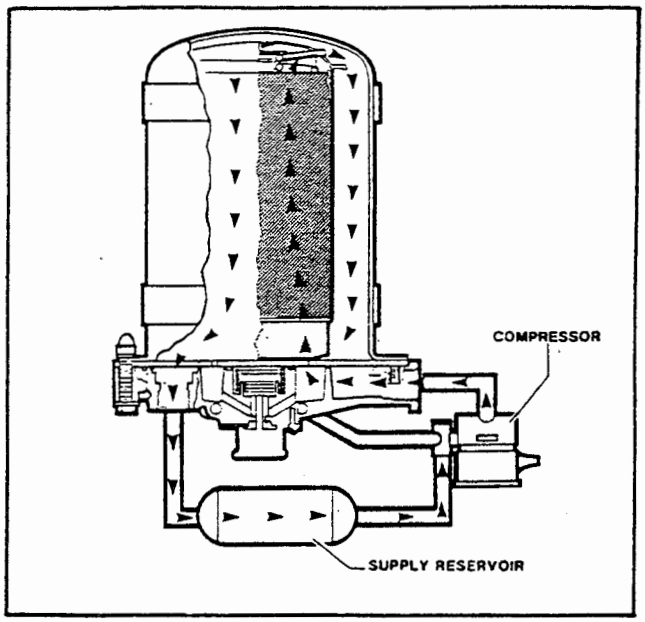


Figure 4-57. Charge Cycle Diagram.

Charge Cycle — Refer to figure 4-57. When the air compressor is loaded (compressing air) compressed air, along with oil, oil vapor, water and water vapor flows through the compressor discharge line to the supply port in the air dryer end cover. The flow velocity, or the speed at which the air and its contaminants travel down the discharge line, is reduced substantially as it enters the air dryer end cover baffle system behind the supply port. As air travels through the baffle system, its direction of flow changes by 180° several times, causing contaminants to condense and drop to the bottom (sump) of the air dryer end cover.

After exiting the end cover baffle system, the air flows into the desiccant cartridge. Once in the desiccant cartridge the air first flows through an oil separator which removes oil, oil vapor and solid contaminants.

Air, still 100% saturated with water vapor, exits the oil separator and enters the desiccant drying bed. Air flowing through the column of desiccant becomes progressively dryer as water vapor adheres to the desiccant material in a process known as "adsorption." The desiccant cartridge using the adsorption process typically removes 95% of the water vapor from the air.

The majority of dry air exits the desiccant cartridge through its integral single check valve to fill the hollow purge volume between the desiccant cartridge and outer shell. Some air will also exit the desiccant cartridge through the purge orifice adjacent to the check valve.

Dry air flows out of the purge volume through the single check valve and out the delivery port to the first (supply) reservoir of the air system.

The air dryer will remain in the charge cycle until air brake system pressure builds to the governor cutout setting

MC-9 MAINTENANCE MANUAL

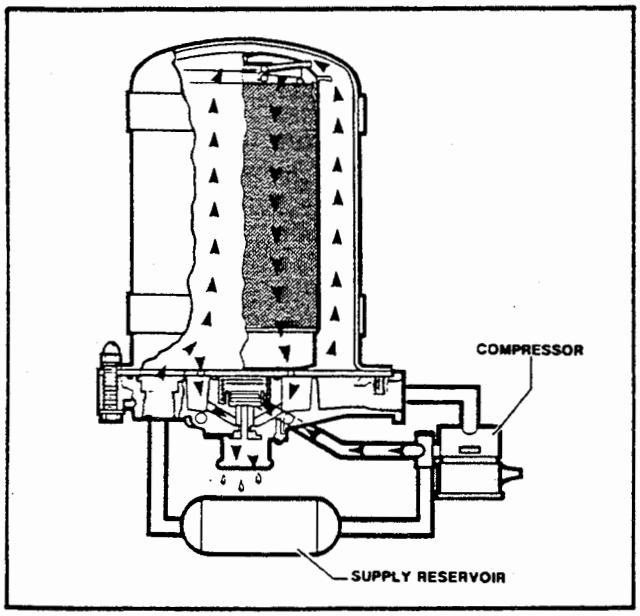


Figure 4-58. Purge Cycle Diagram.

Purge Cycle — Refer to figure 4-58. When air brake system pressure reaches the cutout setting of the governor, the compressor unloads (air compression stops) and the purge cycle of the air dryer begins. The line connecting the governor unloader port to the AD-4 end cover control port is pressurized when the governor unloads the compressor. Air pressure at the AD-4 end cover control port is also present on the purge valve piston. The purge valve piston moves in response to air pressure causing the purge valve to open to atmosphere.

Contaminants in the end cover sump are expelled immediately when the purge valve opens. Also, air which was flowing through the desiccant cartridge changes direction and begins to flow toward the open purge valve. Oil and solid contaminants collected by the oil separator are removed by air flowing from the desiccant drying bed to the open purge valve.

The initial purge and desiccant cartridge decompression lasts only a few seconds and is evidenced by an audible burst of air at the AD-4 exhaust.

The actual reactivation of the desiccant drying bed begins as dry air flows from the purge volume through the desiccant cartridge purge orifice and into the desiccant drying bed. Pressurized air from the purge volume expands after passing through the purge orifice; its pressure is lowered and its volume increased. The flow of dry air through the drying bed reactivates the desiccant material by removing the water vapor adhering to it. Generally 15 to 30 seconds are required for the entire purge volume of a standard AD-4 to flow through the desiccant drying bed.

The end cover single check valve prevents air pressure in the brake system from returning to the air dryer during the purge cycle. After the 30-second purge cycle is complete, the air dryer is ready for the next charge cycle to begin. The purge valve will remain open after the purge cycle is complete and will not close until air brake system pressure is reduced and the governor signals the compressor to charge.

MAINTENANCE

The desiccant cartridge should be replaced or rebuilt when the desiccant is contaminated and does not have adequate water adsorbing capacity. However, the following checks should be made before replacing the desiccant cartridge to ascertain that the water accumulation is not related to the below listed conditions.

A. An outside air source has been used to charge the coach air system. This air did not pass through an air dryer.

B. Air usage is exceptionally high and not normal for the coach. This may be due to accessory air demands or some unusual air requirement that does not allow the compressor to load and unload (compressing and non-compressing cycles) in a normal fashion. Check for high air system leakage.

C. The air dryer has been installed on a coach that has been previously used with a defective air dryer. This sytem will be saturated with moisture and several weeks of operation may be required to dry it out.

Every 900 operating hours or 25,000 miles, or every three months, perform the following maintenance procedure:

1. Check for moisture in the air brake sytem by opening reservoirs, drain cocks or valves, and checking for the presence of water. If mositure is present, the desiccant may require replacement; however, the conditions above should be considered before the desiccant cartridge is replaced.

> **NOTE: In areas where more than an approximate 30°F (17°C) range of temperature is common, small amounts of water can accumulate in the air brake system due to condensation. The presence of small amounts of water is normal.**
>
> **In addition, a small amount of oil in the system may be normal and should not be considered a reason to replace the desiccant. Oil-stained desiccant can function adequately.**

2. Check mounting bolts for tightness. Retighten to 300 lb-in (34 Nm) torque.

3. Check the operation of the check valve in the end cover of the AD-4. Build the air system to governor cut-out (115-118 psi/793-814 kPa) and observe the test air gauge installed in the wet air tank reservoir. A rapid loss of pressure could indicate a failed check valve. This can be confirmed by checking at the purge valve exhaust.

> **NOTE: Purge valve will be open when governor cut-out pressure is reached. Allow two minutes for purge cycle before testing the check valve.**

4. Check for excessive leakage at the purge valve by coating the exhaust with a soap solution while the compressor is loaded (compressing air).

5. Check the operation of the safety valve (figure 4-59) by pulling the exposed stem while the compressor is loaded (compressing air). There must be an exhaust of air while the stem is held and the valve should reseat when the stem is released.

6. Check all lines and fittings leading to and from the air dryer for leakage and integrity.

7. The desiccant change interval may vary with different coaches. Although typical desiccant cartridge life is three years, it may perform adequately for a longer period of time. In order to take maximum advantage of desiccant life and assure that replacement occurs only when necessary, it is important that the following checks be made.

8. Check the operation of the end cover heater and thermostat assembly during cold weather operation, as detailed in a, b and c, below. If the resistance values obtained are within the stated limits, the thermostat and heater are operating properly. If the resistance values are outside the stated limits, proceed to step d to determine the cause.

a. With the coach ignition ON, check for power between the dryer's electrical terminal and metal end cover with a voltmeter or test light.

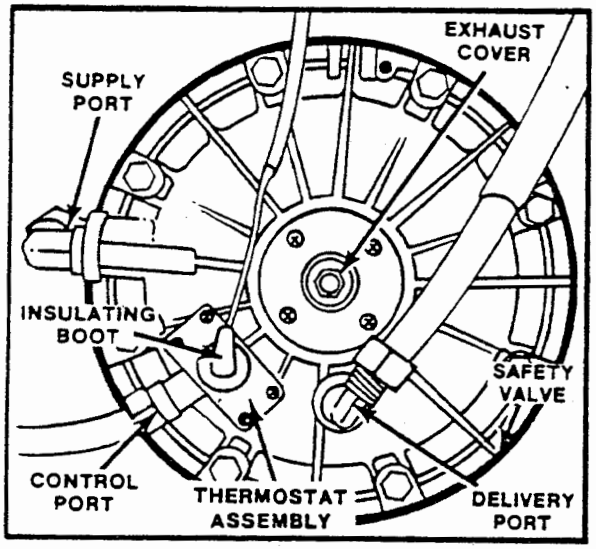


Figure 4-59. AD-4 End Cover (Bottom View).

b. Turn off the ignition and cool the end cover assembly to below 40°F (4°C). Using an ohmmeter, check the resistance between the electrical terminal (pull boot back) and the metal end cover (see figure 4-59). Resistance should be 4.0-7.0 ohms.

c. Warm the end cover assembly to over 90°F (32°C) and check the resistance as in b, above. The resistance should exceed 1000 ohms.

d. With the ignition OFF, remove the thermostat cover (see figure 4-60). Using an ohmmeter, check the resistance between the metal end cover and the heater post (figure 4-60). It should be 4.0-6.0 ohms. If the resistance reading is outside the stated limits, a new or remanufactured end cover should be installed, since the heater element cannot be serviced.

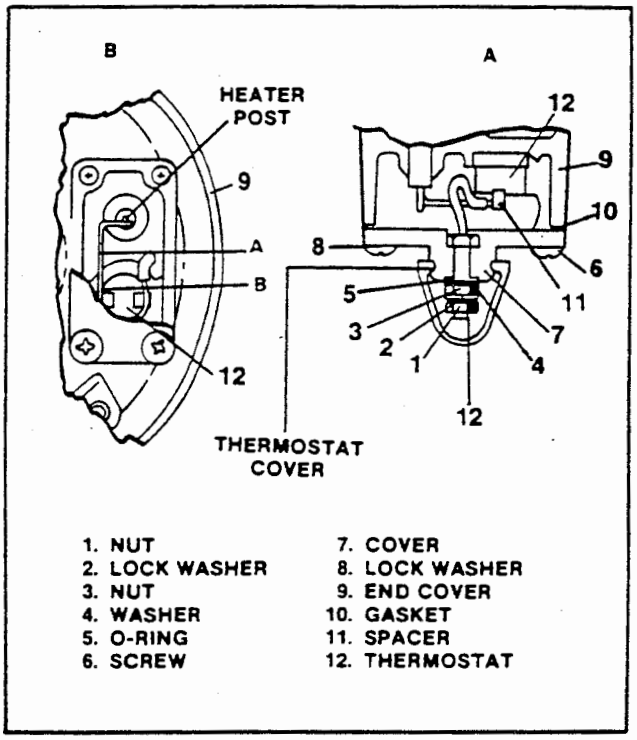


Figure 4-60. Thermostat Assembly.

If the heater resistance value obtained is within the stated limits, the thermostat should be replaced or a new or remanufactured end cover installed. (Ordering information is found below.)

Reassembly — Reinstall the thermostat cover as illustrated in figure 4-59. Take care to assure the rubber spacer and the gasket are correctly installed, to assure proper operation.

REPAIR

For ease in servicing the AD-4, it is recommended that it be removed from the coach

> **NOTE: When only the purge valve is being serviced there is no need to remove the dryer from the coach.**

Maintenance kits are available from Universal Coach Parts, Inc., Northlake, IL.

REMOVAL

1. Make sure the coach is safely parked. Block the wheels if necessary.

2. Vent the air system completely, being sure that the lines leading into and out of the air dryer are at atmospheric pressure.

NOTE: Observe basic safety rules so leaking air springs will not present a safety hazard.

3. Remove the metal shroud protecting the air dryer.

4. Identify and disconnect the three air lines from the end cover and note the position of the end cover ports relative to the coach.

5. Pull the boot from the thermostat and heater cover and slide it onto the wire to expose the connection. Remove the nut and disconnect the electrical wire from the thermostat terminal.

6. Refer to figures 4-61 and 4-62. Loosen the two 5/16 x 4½" hex bolts securing the mounting straps on the back side of the dryer. Disengage the mounting bracket hook from the end cover.

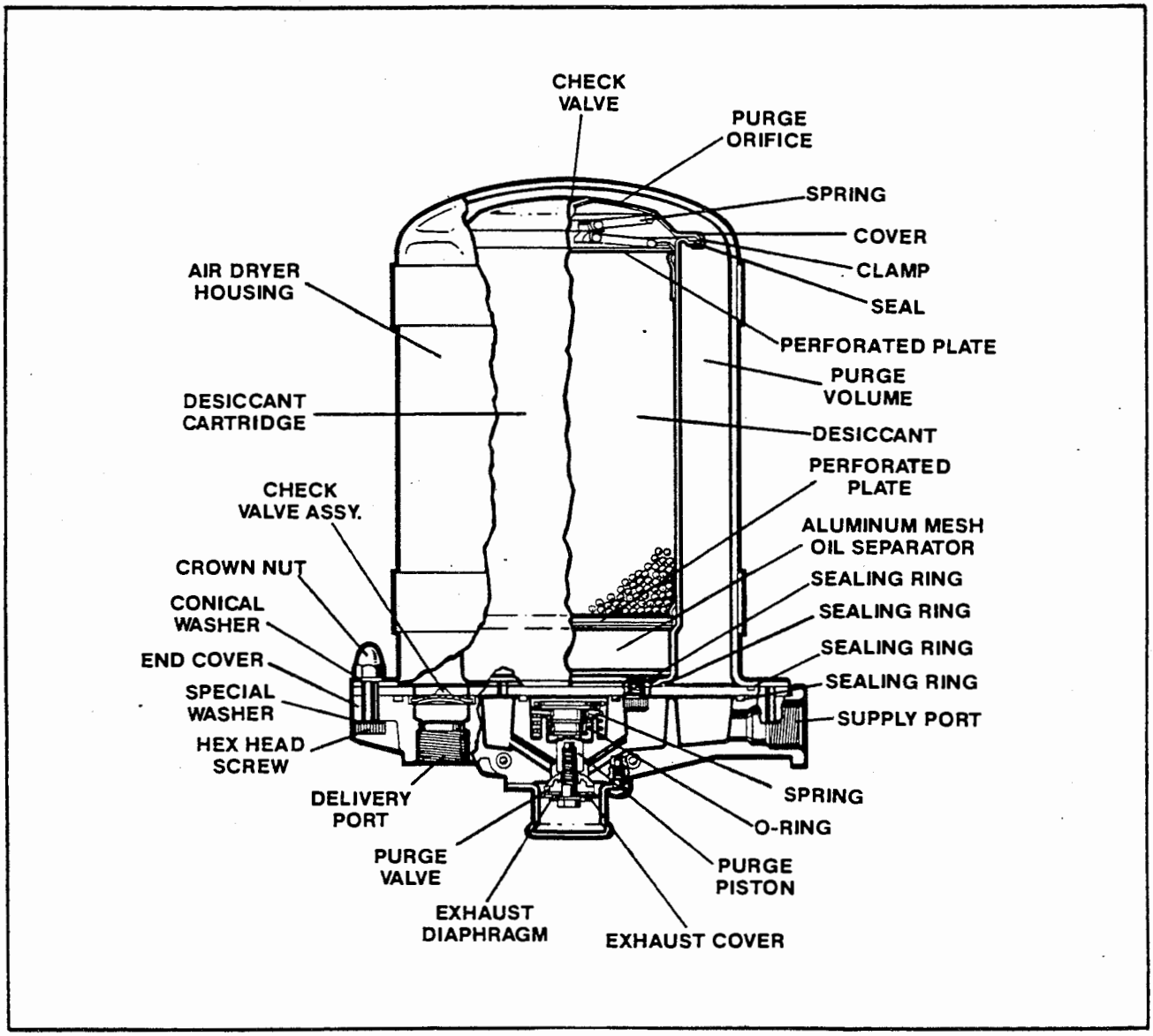


Figure 4-61. AD-4 Air Dryer Cross Section.

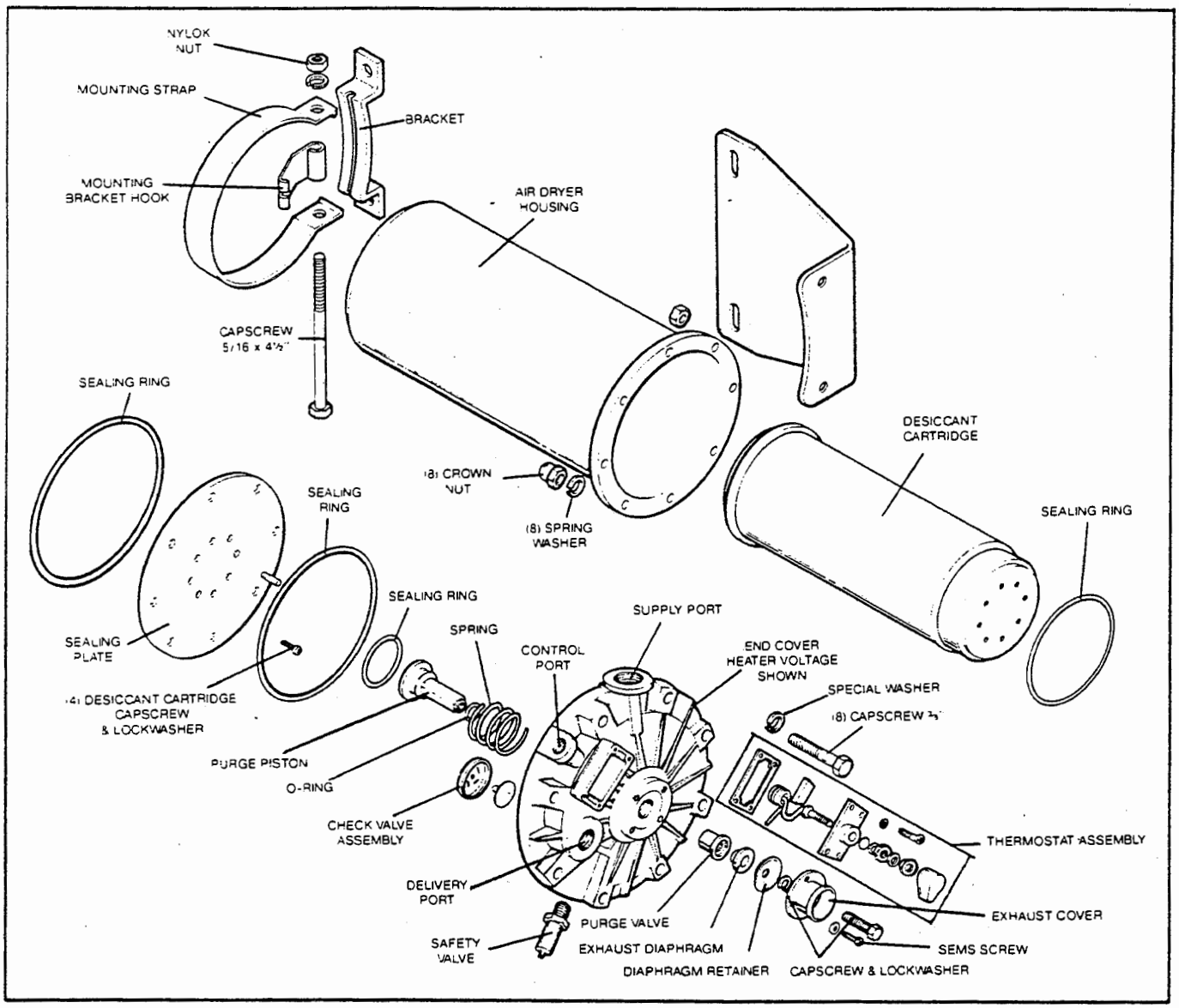


Figure 4-62. AD-4 Parts Breakdown.

DISASSEMBLY

1. Refer to figure 4-62. Remove the eight ⅜" crown nuts, spring washers, special washers and capscrews from the flange of the air dryer and separate the end cover from the air dryer shell.

2. Separate the desiccant cartridge and sealing plate from the end cover. Remove and discard the three sealing rings. One sealing ring is located in the groove on the sealing plate and the other two are in grooves in the end cover.

3. Remove the ¼" capscrew and lock washer from the bottom of the purge valve and remove the diaphragm retainer, exhaust diaphragm and purge valve. Discard the exhaust diaphragm and purge valve. Remove the purge valve piston and discard the O-ring.

4. Remove and discard the check valve assembly in the recess at the delivery port on the end cover.

5. Remove the safety valve from the end cover (only if it has been determined during service checks that it needs replacement.)

6. To remove the thermostat, see Thermostat Repair, below (only if it has been determined that it needs replacement).

7 Remove the exhaust piston and spring from the top side of the cover.

8. Remove the O-ring from the exhaust piston and discard the O-ring.

9. Remove the four ¼" capscrews and lock washers that secure the sealing plate to the desiccant cartridge. Separate the sealing plate from the desiccant cartridge and discard the sealing ring at the base of the cartridge.

ASSEMBLY

Prior to assembly, wash all metal parts thoroughly using a quality commercial solvent (such as mineral spirits). Inspect all parts for wear or damage and replace any parts that fail this visual inspection.

1. Refer to figure 4-62. Place the purge valve spring into the cavity in the center of the top side of the end cover.
2. Lubricate the piston O-ring with a barium base lubricant, and install the O-ring on the purge valve piston and place the piston inside the spring installed in step 1.
3. Turn the cover over on a flat, clean surface (making sure the purge valve piston and spring remain in proper position). Compress the spring by pushing down on the cover and align the square shank of the purge valve piston into the mating hole in the cover.
4. Place the washer, diaphragm retainer, diaphragm and purge valve onto the purge valve capscrew.
5. Install the purge valve capscrew with parts on it into the exhaust cover and tighten to 30-40 lb-in (3.4-4.5 Nm) torque.
6. Install the safety valve (if removed) and tighten to 120-400 lb-in (13.5-45.0 Nm) making sure that the exhaust hole is pointed downward when the dryer is installed.
7. Install the thermostat (if removed). Refer to instructions pertaining to thermostat installation, below.
8. Place the sealing ring on the bottom of the desiccant cartridge. Attach the cartridge to the plate (smooth side of plate opposite cartridge) with four socket head capscrews and lock washers. Tighten to 80-100 lb-in (9.0-11.3 Nm) torque.
9. Lubricate and install the two sealing rings in the recesses of the end cover. Use a barium base lubricant.
10. Install the check valve assembly into the cover making sure the holes in the metal stamping are facing up and the tang on the check valve assembly fits into the mating recess in the cover.
11. Place the desiccant cartridge and sealing plate assembly onto the cover taking care not to displace the sealing rings. The large hole in the sealing plate must line up with the check valve and the spirol pins in the sealing plate must enter the corresponding holes in the end cover.
12. Lubricate the outer sealing ring with barium base lubricant and install on the sealing plate. Place the housing of the air dryer over the desiccant cartridge (lining up the marks on the housing and cover made prior to disassembly) and retain with eight ⅜" hex head bolts, special washers and crown nuts. Tighten to 270-330 lb-in (30.7-37.5 Nm).

NOTE: If the ⅜-24 x 2½" bolts require replacement, insure that the replacement bolts are grade 5 minimum. Use of inferior bolts can compromise the integrity of the air dryer and lead to premature failure.

13. Install the assembled AD-4 air dryer on the coach by sliding it into the mounting brackets until the mounting bracket hook catches under the lip of the cover and tighten the mounting bracket bolts to the 70-85 lb-in (7.9-9.6 Nm).
14. Reconnect the three air lines to the proper port on the cover (identified during disassembly).
15. Reconnect the thermostat and heater wire and place the boot in position to protect the connection by forcing it over the knob on the plastic cover.
16. Install the dryer shroud with the retained mounting hardware.
17. Test the air dryer as outlined under Maintenance, above.

THERMOSTAT REPAIR

1. Refer to figure 4-60. Remove nut (1), then lock washer (2) nut (3), washer (4) and O-rings (5). Discard O-rings and retain other parts.
2. Remove and retain the four Phillips head screws (6) and cover (7).
3. Remove and discard gasket (10).
4. Remove and retain spacer (11).
5. Cut uninsulated thermostat wire at Point B (figure 4-62), remove and discard thermostat and terminal assembly (12).
6. Clean remaining wire attached to heater terminal.
7. Clean thermostat "pocket" in end cover (9).

NOTE: Steps 8 thru 16 are for thermostat assembly.

8. Cut the uninsulated lead of the new thermostat at point A (figure 4-60).
9. Install the thermostat in the end cover pocket and position the uninsulated leads next to each other.
10. Using a soldering heat sink, clamp the uninsulated leads at point B (figure 4-60) and solder the leads with straight rosin core solder. DO NOT USE ACID CORE SOLDER as corrosion can result. Clean excess solder off end cover.
11. Install thermostat terminal (12) in cover (6).
12. Install O-ring (5), washer (4) and nut (3). Tighten nut to 20-30 lb-in (2.3-3.4 Nm) torque. Then install lock washer (2) and nut (1) finger tight to allow for reconnection of electrical wire when reinstalled on coach.
13. Install spacer (11) over thermostat (12).
14. Install gasket (7) and thermostat cover (6) and secure thermostat cover to end cover (9) using screws (7) and lock washers (8).
15. Tighten to 30-40 lb-in (3.4-4.5 Nm) torque.
16. Test the thermostat as follows:

a. At a temperature above 90°F (32°C), check the resistance between the thermostat terminal (2) and end cover (9). Resistance should be 1000 ohms or greater. If not, check for solder short.

b. Chill the end cover assembly to 40°F (4°C) and check resistance again. Resistance should be 4-7 ohms.

MC-9 MAINTENANCE MANUAL

TROUBLESHOOTING

1. **Air Pressure Drops Quickly With Engine Stopped and Brakes Released**

   Leaking brake valve tubing or hose line
   Compressor discharge valves leaking
   Compressor governor leaking
   Leaking elsewhere in the air brake system

2. **Air Pressure Drops Quickly With Engine Stopped and Brakes Fully Applied**

   Leaking brake chamber diaphragm
   Leaking brake cylinder or brake valve
   Leaking tubing or hose line

3. **Brakes Grab**

   Grease on brake lining — reline brakes
   Brake drum out of round
   Defective brake valve
   Brake rigging binding

4. **Insufficient Brakes**

   Brakes need adjusting, lubricating or relining
   Low air pressure in brake system — below 80 pounds (522 kPa)
   Brake valve delivery pressure below normal

5. **Brakes Apply Too Slowly**

   Brakes need adjusting or lubricating
   Low air pressure in the brake system — below 80 PSI (522 kPa)
   Brake valve delivery pressure below normal
   Excessive leakage with brakes applied
   Restricted tubing or hose line

6. **Brakes Release Too Slowly**

   Brakes need adjusting or lubricating
   Brake valve not returning to fully released position
   Restricted tubing or hose line
   Exhaust port of brake valve or quick release valve restricted or plugged
   Defective brake valve or quick release valve

7. **Brakes Do Not Apply**

   No air pressure in brake system
   Restricted or broken tubing or hose line
   Defective brake valve

8. **Brakes Do Not Release**

   Brake rigging binding
   Brake valve not in fully released position
   Defective brake valve
   Restriction in tubing or hose line

9. **Uneven Brakes**

   Brakes need adjusting, lubricating or relining
   Grease on brake lining — reline brakes
   Brake shoe release spring or brake chamber release spring broken
   Brake drum out of round
   Brake chamber diaphragm leaking

10. **Air Pressure Will Not Rise to Normal**

    Defective air gauge (registering incorrectly)
    Excessive leakage
    Reservoir drain cock open
    Governor out of adjustment
    No clearance at compressor unloading valves
    Defective compressor

11. **Air Pressure Rises to Normal Too Slowly**

    Excessive leakage
    Clogged air cleaner
    No clearance at compressor unloading valves
    Engine speed too low
    Compressor discharge valve leakage
    Worn compressor
    Excessive carbon in compressor cylinder head or discharge line

12. **Air Pressure Rises Above Normal**

    Defective air gauge (registering incorrectly)
    Compresor governor out of adjustment
    Defective compressor governor
    Restriction in line between governor and compressor unloading mechanism
    Too much clearance at compressor unloader valves
    Unloading valve cavities or unloading passage in compressor cylinder head blocked with carbon
    Compressor unloading valves stuck closed

13. **Compressor Fails to Maintain Sufficient Pressure in Air System**

    Dirty intake strainer
    Restriction in compressor inlet or discharge lines or cavities
    Leaking or broken discharge valves
    Drive coupling slipping
    Ir let valves worn excessively or stuck open
    Excessive air system leakage
    Excessive wear on piston rings and/or cylinders

14. **Noisy Compressor Operation**

    Loose drive gear
    Excessively worn drive coupling
    Worn or burned out bearings
    Excessive wear
    Improper lubrication to the compressor
    Restrictions in the cylinder head or discharge line

TROUBLESHOOTING

15. Compressor Passes Excessive Oil

Dirty air strainer
Oil supply lines to compressor or return lines flooded
Back pressure from engine crankcase
High inlet vacuum at the compressor
Excessive engine oil pressure
Defective oil seal or oil seal ring in end cover
Piston rings improperly installed
Excessive ring or cylinder wear

16. Compressor Knocks Continuously or Intermittently

Loose drive gear
Worn or burned out bearings
Excessive carbon deposits in compressor cylinder head

17. Compressor Fails to Unload

Defective or worn unloader pistons or bores
Inlet cavity restrictions
Defective governor
Unloader line from governor pistons kinked or the cavity beneath the unloader pistons restricted
Unloader mechanism binding or kinked

18. Safety Valve "Blows Off"

Safety valve out of adjustment
Air pressure in the air brake system above normal

19. Dryer is Constantly "Cycling" or Purging

Excessive system leakage
Defective check valve between air dryer and first reservoir (check valve to outlet port)
Defective governor
Leakage purge valve in air dryer end cover (control side)
Compressor unloader mechanism leaking excessively

20. Water in Air System Reservoirs

Desiccant requires replacement
Air system charged from outside air source (outside air not passing through air dryer)
Air dryer not purging (see Symptom #23)
Purge (air exhaust) time insufficient due to excessive system leakage (see causes for Sympton #19)

21. Safety Valve on Air Dryer "Popping Off" or Exhausting Air

Desiccant cartridge plugged or saturated
Defective check valve between air dryer outlet port and first reservoir (check valve in outlet port)
Defective fittings, hose or tubing between air dryer and first reservoir

22. Constant Exhaust of Air at Air Dryer Purge Valve Exhaust or Unable to Build System Pressure

Air dryer purge valve leaking excessively
Defective governor
Purge control line connected to reservoir or exhaust port of governor
Purge valve frozen open — faulty heater and thermostat, wiring, blown fuse
Inlet and outlet air connections reversed
Check valve between air dryer and first reservoir defective
Kinked or blocked (plugged) discharge line
Excessive bends in discharge line (water collects and freezes)
Excessive system leakage

23. Air Dryer Does Not Purge or Exhaust Air

Broken, kinked, frozen, plugged or disconnected purge control line
Faulty air dryer purge valve
See causes for Symptom #22

24. Desiccant Material Being Expelled from Air Dryer Purge Valve Exhaust (may look like whitish liquid or paste or small beads)

This symptom is almost always accompanied by one or more of 19 to 23; see related causes for these symptoms above
Air dryer not securely mounted (excessive vibration)

Or Unsatisfactory Desiccant Life

Defective cloth covered perforated plate in air dryer desiccant cartridge or improperly rebuilt desiccant cartridge
Compressor passing excessive oil
Faulty heater and thermostat, wiring, fuse not allowing purge (cold weather operation only)

25. Unable to Remove End Cover, or Unable to Install New Desiccant Cartridge

Result of reversing the inlet and outlet connections

26. Air Dryer End Cover Separates From Air Dryer Housing During Operation

Excessive system pressure built up within air dryer; caused by either plugged desiccant, check valve failure, frozen or obstructed discharge line (between air dryer and first reservoir) or governor failure in conjunction with safety valve failure

MC-9 MAINTENANCE MANUAL

SPECIFICATIONS

AIR COMPRESSOR
- Manufacturer ..... Bendix
- Model ..... Tu Flo 700
- TMC/MCI Part No. Standard (Alum Connecting Rods) 4R-7-1
- TMC/MCI Part No. Optional (Steel Connecting Rods) 4R-7-2
- Displacement ..... 15.5 cu. ft. (439 liters)
- Maximum RPM ..... 3000 (recommended)

CYLINDER BLOCK
- Bores
  - Out-Of-Round ..... .001" max

CYLINDER HEAD
- Capscrew Torque ..... 175-225 in. lbs. (19.7-25.4 Nm)

CRANKCASE
- (With Ball Bearing Main Bearings) Gap Between Outer Race O.D. and Crankcase Bore I.D. ..... .0000"-.0015" (0-.0381 mm)
- (With Sleeve-Type Main Bearings) Gap Between Crankshaft Journal O.D. and Main Bearing I.D. ..... .005" (.127 mm) max

PISTONS
- Clearance Between Cylinder Bore and Piston ..... .002"-.004" (.051-.102 mm)
- Clearance Between Wrist Pin and Piston ..... None - light press fit required
- Oversize Pistons Available ..... .010" (.254 mm)
  .020" (.508 mm)
  .030" (.762 mm)

PISTON RINGS
- Ring Gap (In Cylinder) ..... .002"-.004" (.051-.102 mm)
- Clearance Between Ring and Ring Groove ..... .002"-.004" (.051-.102 mm)

CRANKSHAFT
- Standard Journal O.D. ..... 1.1250"-1.1242" (28.575-28.555 mm)
- Journal Regrind Specifications ..... .010" (.254 mm) Undersize
  .020" (.508 mm) Undersize
  .030" (.762 mm) Undersize
- Clearance Between Sleeve Bearing and Main Bearing Journal ..... .005" (.127 mm) max
- Clearance Between Ball Bearing and Main Bearing Journal ..... None - snug fit required

CONNECTING RODS
- Clearance Between Wrist Pin O.D. and Connecting Rod Bushing ..... .0002"-.0007" (.00508-.01778 mm)

If Wrist Pin/Bushing Clearance Is Worn, It Can Be Replaced If Connecting Rods Are Steel; If Rods Are Aluminum, New Rod Assembly Must Be Installed.

Clearance Between Connecting Rod Journal and Rod Bearing (After Rebuilding) ..... .0003"- 0022" (.0076-.0533 mm)

Torque for Bolts on Rod Caps ..... 125-140 in. lbs. (14.1-15.8 Nm)

DISCHARGE VALVE TRAVEL ..... .030"-.046" (.762-11.68 mm)

INLET VALVE
- Distance From Cylinder Block Top to Inlet Valve ..... .101"-.113" (2.56-2.87 mm)

GOVERNOR
- Manufacturer ..... Bendix
- Model D-2
- TMC/MCI Part. No. 4C-8-33

MC-9 MAINTENANCE MANUAL

SPECIFICATIONS

Cut-In Pressure ..... 95-105 psi (655-724 kPa)
Cut-Out Pressure ..... 115-118 psi max. (793-814 kPa)
Exhaust Valve Travel ..... .060"-.093" (1.524-2.362 mm)
Inlet Valve Travel ..... .030"-.040" (.762-1.016 mm)

BRAKE CHAMBERS

	FRONT	REAR	TRAILING
Manufacturer	Bendix	Bendix	Bendix
Type	24	30	12
Diameter	7¼" (184.1 mm)	8⅛" (206.3 mm)	5-21/32" (143.6 mm)
Max. Stroke	2¼" (57.1 mm)	3" (76.2 mm)	1¾ (44.4 mm)
Min. Stroke (w/Brake Adj.)	1¾" (44.4 mm)	1½" (38.1 mm)	1⅜" (34.9 mm)
Effective Diaphragm Area	24 sq. in. (6.1548 sq. cm)	30 sq. in. (193.5 sq. cm)	12 sq. in. (77.4 sq. cm)

AIR LINE CHECK VALVE

Manufacturer ..... Bendix
Model No. 229603
MCI Part No. 4C-22-17
Air Pressure Differential ..... 2 psi (13.8 kPa)

SLACK ADJUSTERS (MANUAL)

Manufacturer ..... Bendix Westinghouse
Model No. ..... LH Front & RH Rear 288538
RH Front & LH Rear 288537

SLACK ADJUSTERS (AUTOMATIC)

Manufacturer ..... SAB
Model No. ..... LH Front & RH Rear 409-10029
RH Front & LH Rear 409-10030

Date 1-1-89

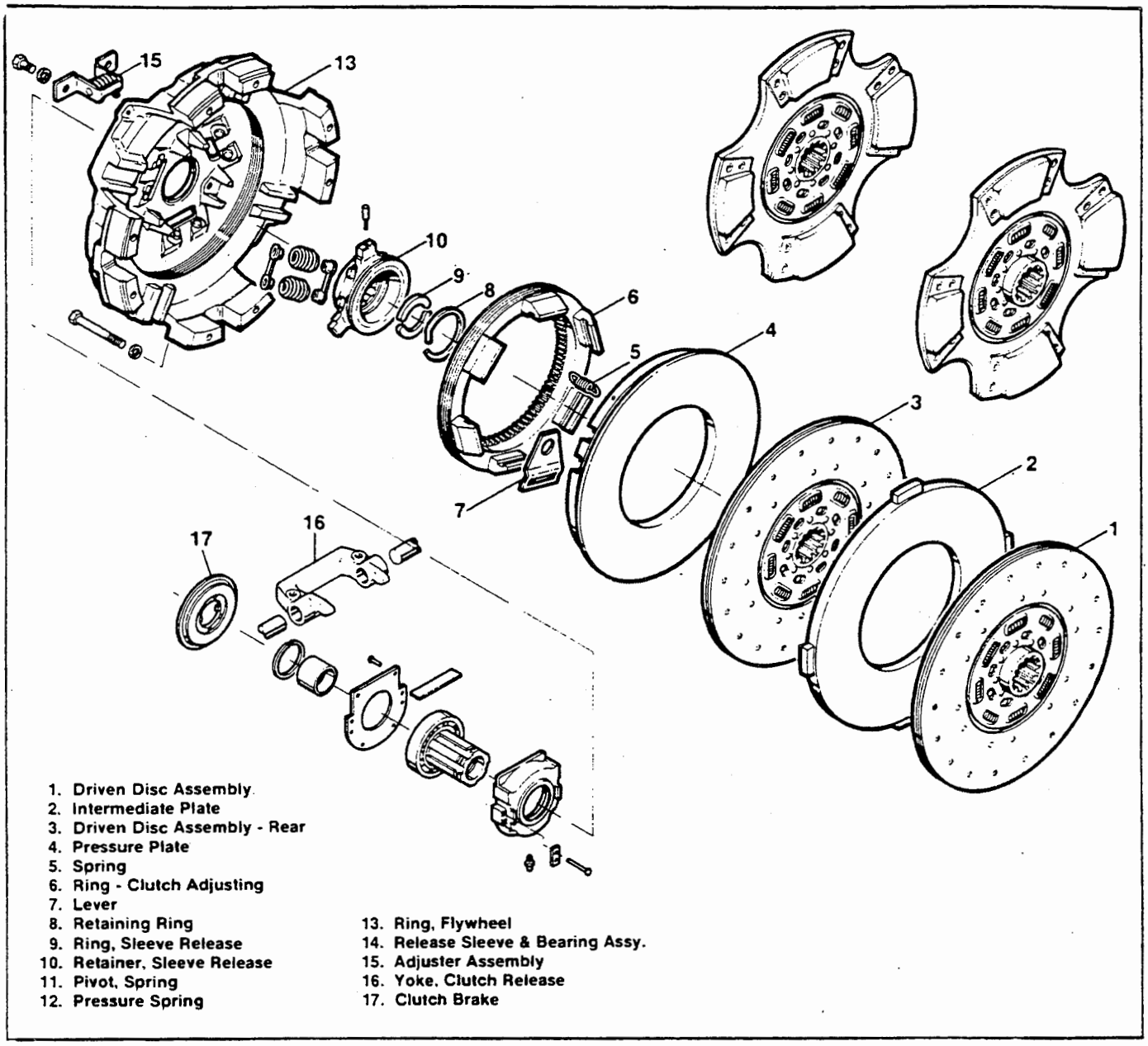
MC-9 MAINTENANCE MANUAL

SECTION 5

CLUTCH

SUBJECT	PAGE
Assembly	5-6
Clutch Brake	5-12
Clutch Pedal Adjustment	5-3
Clutch Life Remaining	5-13
Clutch Linkage Adjustment	5-1
Clutch Repair	5-3
Disassembly	5-4
Engine and Transmission Alignment	5-9
Inspection	5-6
Installation of Transmission to Clutch and Engine	5-10
Installing Clutch on Flywheel	5-10
Lubrication	5-13
Pre-Installation Checks	5-10
Service Tools	5-16
Specifications	5-15
Troubleshooting	5-14
Service Bulletin Page	

MC-9 MAINTENANCE MANUAL



1. Driven Disc Assembly
2. Intermediate Plate
3. Driven Disc Assembly - Rear
4. Pressure Plate
5. Spring
6. Ring - Clutch Adjusting
7. Lever
8. Retaining Ring
9. Ring, Sleeve Release
10. Retainer, Sleeve Release
11. Pivot, Spring
12. Pressure Spring
13. Ring, Flywheel
14. Release Sleeve & Bearing Assy.
15. Adjuster Assembly
16. Yoke, Clutch Release
17. Clutch Brake

Figure 5-1. Clutch for 5-Speed Manual Transmission.

CLUTCH

The clutch used with the 5-speed manual transmission is a 15½" dry disc 2-plate model. It is a pull type design with riveted organic facings on driven discs (except with 8V92 — ceramic facings are used). An integral self-adjusting mechanism checks for plate wear each time the clutch is actuated. Manual adjustment can be made on board by turning the adjusting ring (No. 6, figure 5-1) which is accessible through the inspection plate located on the clutch housing.

CLUTCH LINKAGE ADJUSTMENT

With the engine and transmission installed, make the final adjustment of the clutch and linkage as follows.

1. Establish 8.5" (215.9 mm) height between clutch pedal and coach floor (figure 5-2).
2. Connect all front end linkage as shown.
3. Connect rear linkage and adjust clutch rod ends to maintain a 3°-5° (approx.) over center position for the clutch cross shaft levers. Lever travel must be equidistant on either side of vertical position.

MC-9 MAINTENANCE MANUAL

4. Place a 1" (25.4 mm) spacer between the clutch pedal and the coach floor.

5. Depress clutch pedal until contact is made with 1" (25.4 mm) spacer and hold until adjustments of clutch brake and release bearing are made.

6. With a .0015" (.038 mm) strip gauge or equivalent between braking surface of the release bearing and clutch brake, adjust the linkage rod until a slight pull is required to remove the strip gauge. (Three people are required for steps 5 and 6.)

7. Tighten locking nut on adjusting screw.

WITH ALL ADJUSTMENTS COMPLETED, THE FOLLOWING DIMENSIONS SHOULD BE ESTABLISHED

1. .500" (12.7 mm) between release bearing and clutch brake with clutch pedal released.

2. Approx. .125" (3.175 mm) free travel between release yoke fingers and release bearing wear pads.

3. Between 1.5" and 2" (38.1-50.8 mm) free movement at the top of the clutch pedal travel.

4. At 1" (25.4 mm) from the floor clutch pedal actuates the clutch brake.

NOTE: All above dimensions must be met to ensure clutch life.

CLUTCH BRAKE ADJUSTMENT

Check the clutch brake clamping force. It should start 1" off the floor. Adjustment is achieved by increasing or decreasing free travel with adjustment bolt on activating lever. Adjustment is very sensitive and should not affect free travel by more than 1/16".

Reinstall inspection plate, tighten all jam nuts, and install "E" clips on shafts and pins.

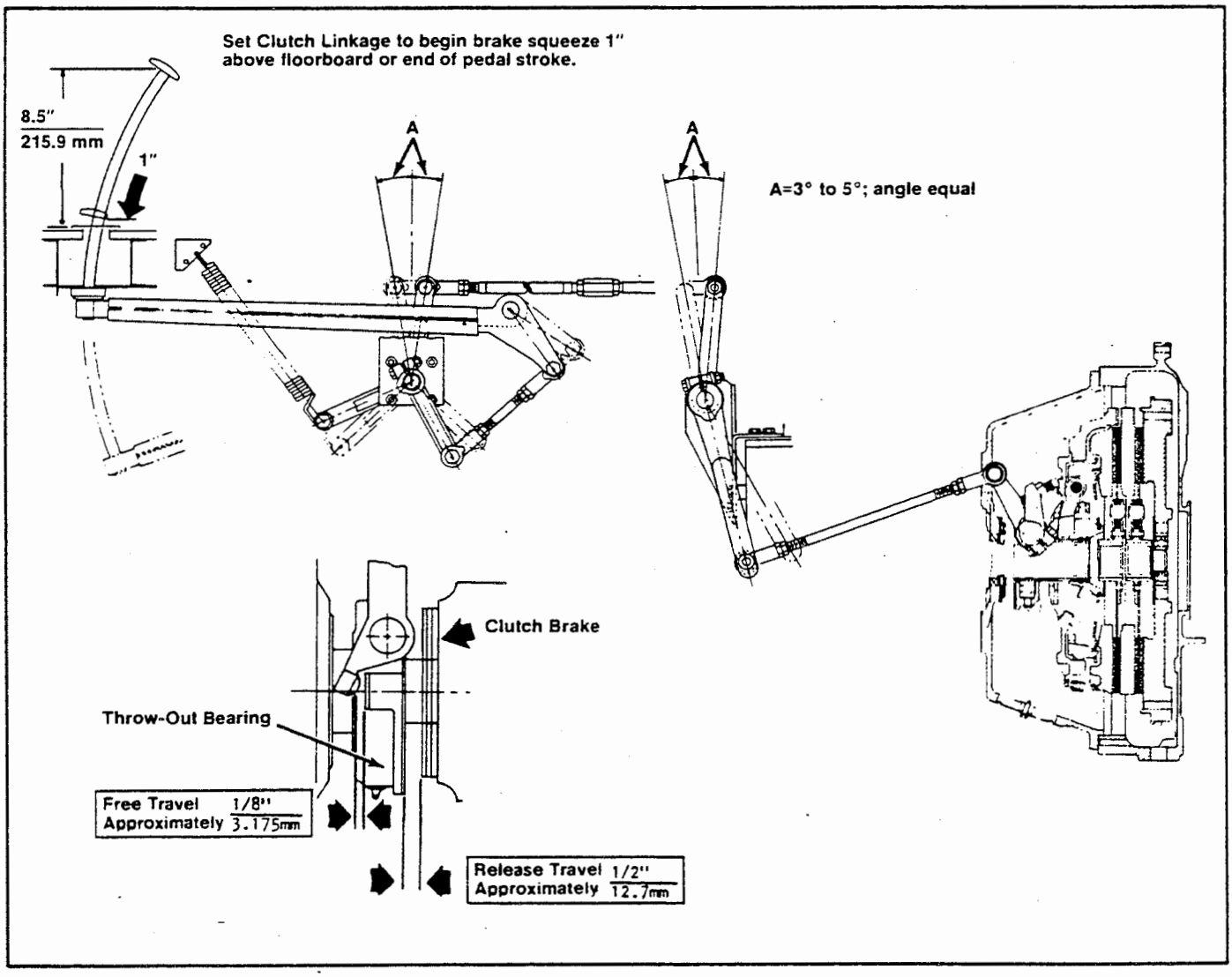


Figure 5-2. Clutch Linkage Adjustment - 5-Speed Manual Transmission.

MC-9 MAINTENANCE MANUAL

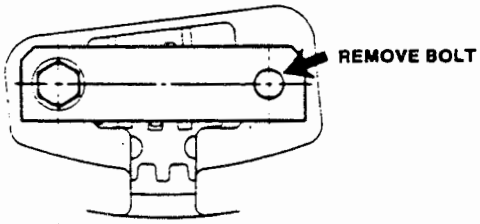
CLUTCH ADJUSTMENT

NOTE: Before installation or removal of clutch, check the following.

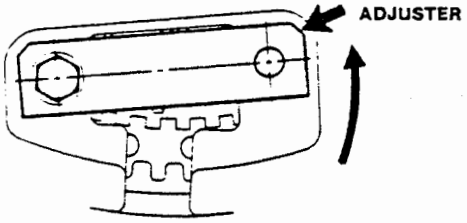
1. Do not remove shipping block until clutch is mounted.
2. Lubricate release bearing; block release bearing to partial release position any time clutch is removed from flywheel.
3. Linkage must have ⅝" (15.9 mm) yoke travel capability.

After installation adjust clutch linkage to ensure that clutch brake actuation occurs when the pedal is 1" (25.4 mm) above the floorboard. If free pedal is less than 1" (25.4 mm), manual adjustment is required. To obtain initial free pedal, see following.

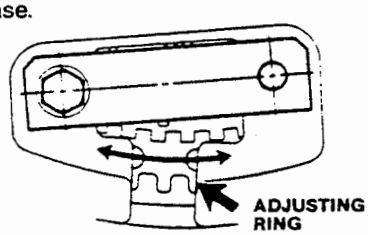
A. Remove right bolt. Loosen left bolt one turn.



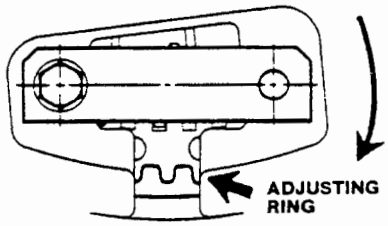
B. Rotate adjuster upward. This will disengage worm gear from the adjusting ring to allow manual adjustment. Hold adjuster disengaged and tighten left bolt.



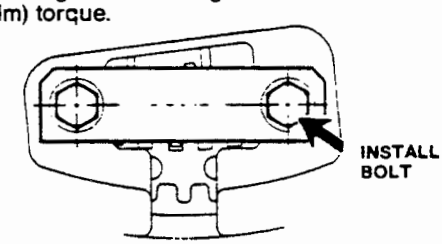
C. Rotate adjusting ring until approximately 1½" (38.1 mm) of free pedal is acquired — pedal must be down. Rotate clockwise to increase free pedal, counterclockwise to decrease.



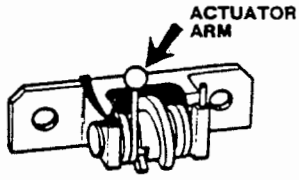
D. Loosen left bolt, rotate adjuster assembly downward to engage worm with adjusting ring teeth. Adjusting ring may have to be rotated slightly to allow worm to mesh.



E. Install right bolt and tighten both bolts to 25-30 lbs. ft. (34-47 Nm) torque.



F. Visually check to see if actuator arm is inserted into release sleeve retainer. (This can be accomplished through bell housing inspection opening.) The adjuster assembly spring will move back and forth if actuator arm is inserted into release sleeve retainer as the pedal is stroked several times. (Spring will move only one time if arm is not inserted.) If the adjuster assembly is not installed properly, proceed to Step 3G.



G. If for any reason the adjuster assembly is removed from the cover assembly for general inspection or replacement, the ball end of the actuator arm must be inserted into the hole of the release sleeve retainer. To insert the ball end into the release sleeve retainer hole, the simplest method is to have the clutch in the release position, pedal down. Let pedal up and adjuster bracket will move toward flywheel ring of cover assembly. Complete installation by installing adjuster bolts.

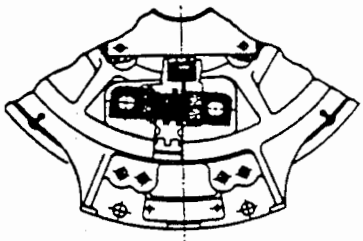


Figure 5-3. Clutch Adjustment Procedures.

CLUTCH REPAIR (CLIP AND PIN LEVER TYPE)

1. Prior to actual clutch removal, assemble a clutch disc aligning tool to the driven disc and release bearing assembly.

NOTE: Two ¾" (19 mm) blocks of wood must be inserted between the clutch release bearing housing and clutch flywheel ring as the clutch mounting bolts are loosened around the flywheel. These blocks will relieve the heavy internal spring load, preventing cocking and bending within the clutch and ensure easy removal of remaining mounting bolts. See figure 5-4.

MC-9 MAINTENANCE MANUAL

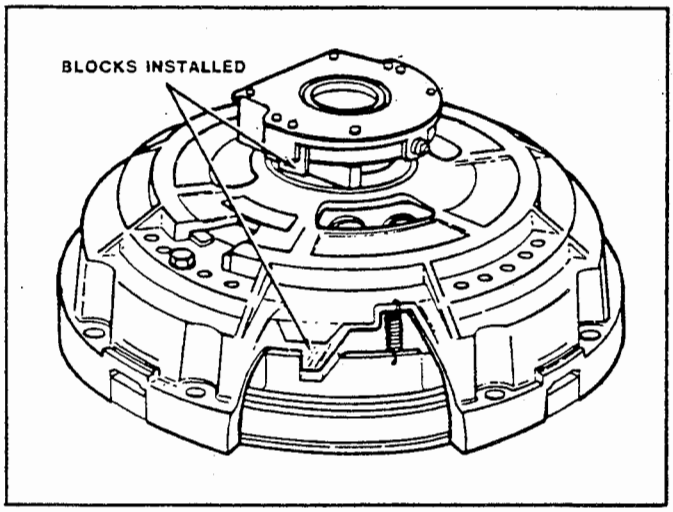


Figure 5-4. Wooden Blocks Inserted.

2. When all bolts have been removed, slide clutch assembly back and off using caution to keep aligning tool in place to retain discs and intermediate plate.

3. Carefully remove aligning tool, rear disc, intermediate plate and front disc.

4. See inspection section for checks of flywheel.

NOTE: This procedure applies directly to the Clip and Pin lever design (earlier production). The procedure for the Knife Edge lever design (current production) is similar. The photos will differ from actual construction.

DISASSEMBLY

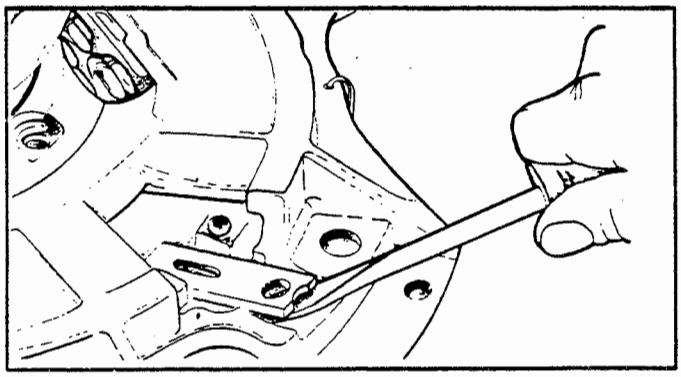


Figure 5-5. Remove Adjusting Ring Lock.

5. Remove bolt and lockwasher assembly and adjusting ring lock. Use screwdriver of similar wedge to remove adjusting ring lock (figure 5-5).

6. Set clutch assembly (without driven discs and intermediate plate) upside down on a flat table or workbench. Unhook four return springs from flywheel ring and lift pressure plate off.

NOTE: Mark pressure plate in relation to the flywheel ring for reassembly purposes.

7. Turn the adjusting ring and lever assembly counterclockwise until free of flywheel ring. Then lift and remove assembly (figure 5-6).

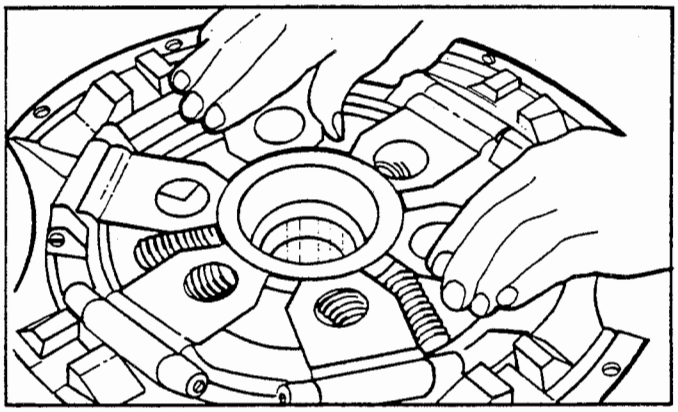


Figure 5-6. Turn Adjusting Ring D-1.

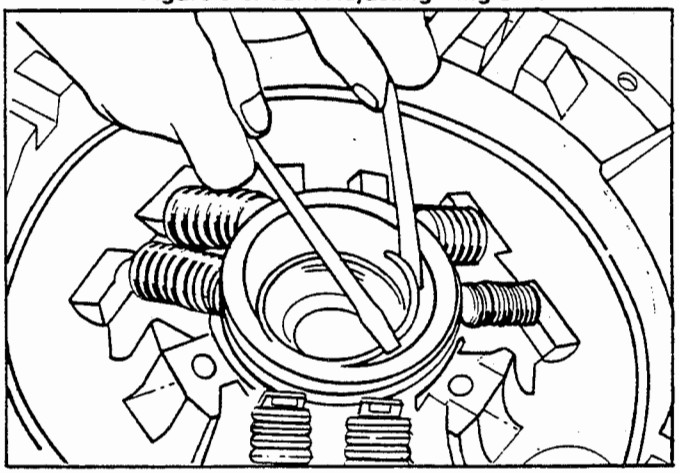


Figure 5-7. Remove Retaining Ring.

8 Remove retaining ring from release sleeve retainer (figure 5-7).

9. Install three 5/16" x 5" (7.9 x 12.7 mm) threaded rods through clearance holes in release sleeve retainer and into holes provided in flywheel ring. Rods must pass through flywheel ring far enough to put hex nuts on both ends (figure 5-8).

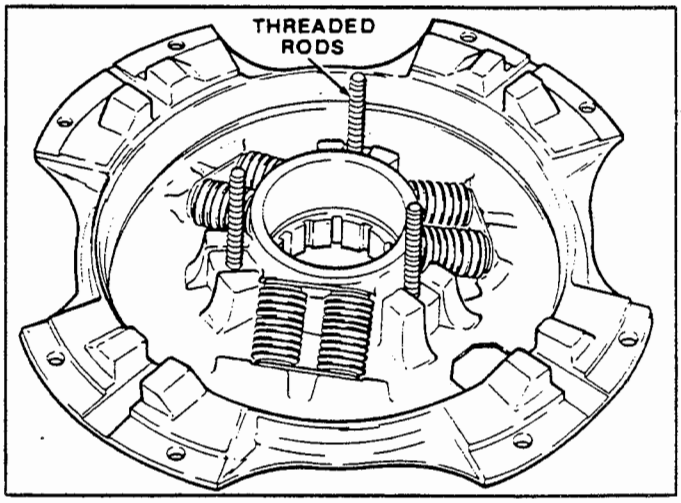


Figure 5-8. Install Threaded Rods.

MC-9 MAINTENANCE MANUAL

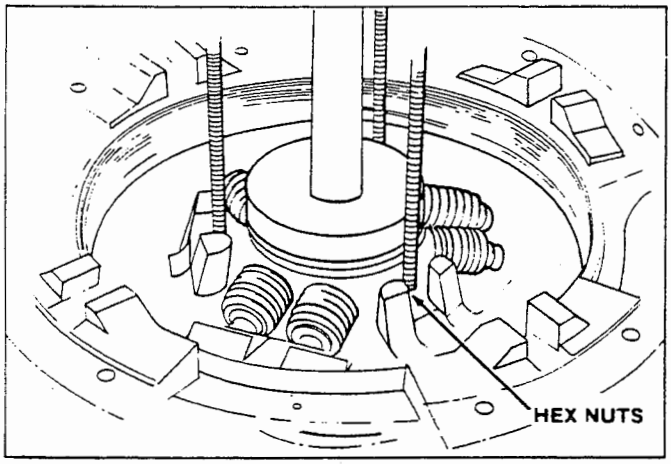


Figure 5-9. Compress Retainer.

10. Place assembly on an arbor press with a piece of tubing (see Note) supporting the release sleeve. Compress retainer until drive lugs bottom on flywheel ring and draw three hex nuts tightly against retainer (figure 5-9).

NOTE: Use a short piece of 2½" or 2¾" O.D. (63.5-69.9 mm) tubing to support release sleeve assembly. Do not support on clutch release bearing cover rivet threads.

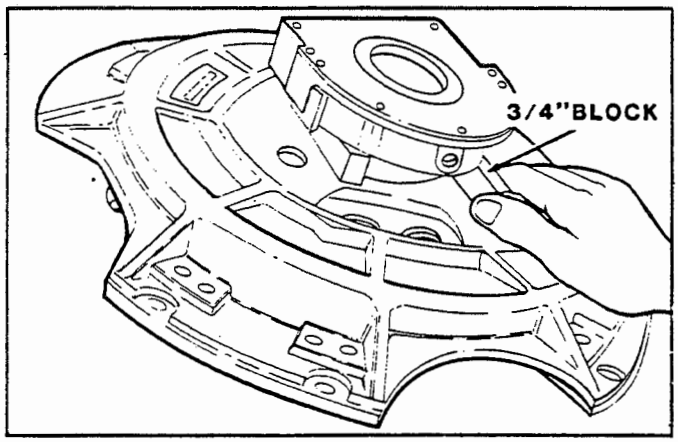


Figure 5-10. Remove Wooden Blocks.

11 Raise arbor. Tilt assembly and remove wooden blocks (figure 5-10).

12. Again support release sleeve on tubing as in Step 10. Remove half ring locks (figure 5-11). Release sleeve and bearing assembly are now free to slide through retainer toward rear of clutch.

13. To disassemble pressure springs and retainer, compress retainer to relieve load on hex nuts. Back off hex nuts and remove load on pressure springs. Remove pressure springs and spring pivots (figure 5-12).

14. To complete disassembly, remove the retainer clip from pivot pins, and remove pins and levers (figure 5-13).

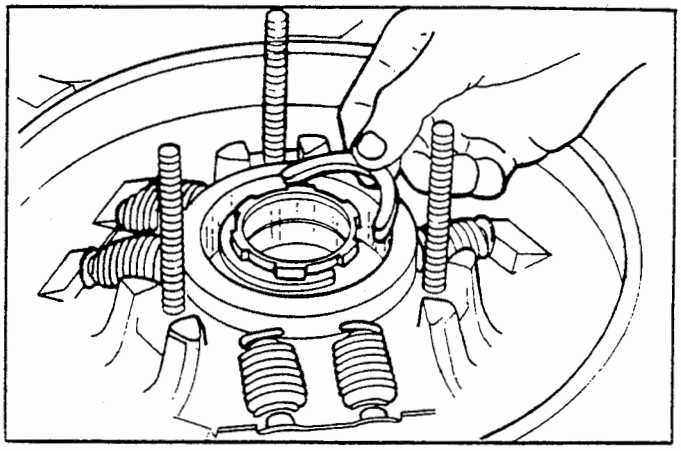


Figure 5-11. Remove Half Ring Locks.

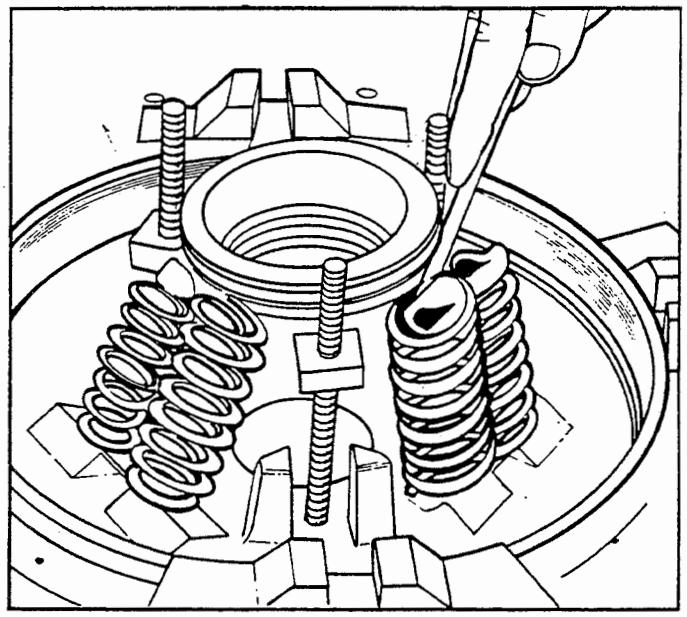


Figure 5-12. Remove Springs and Pivots.

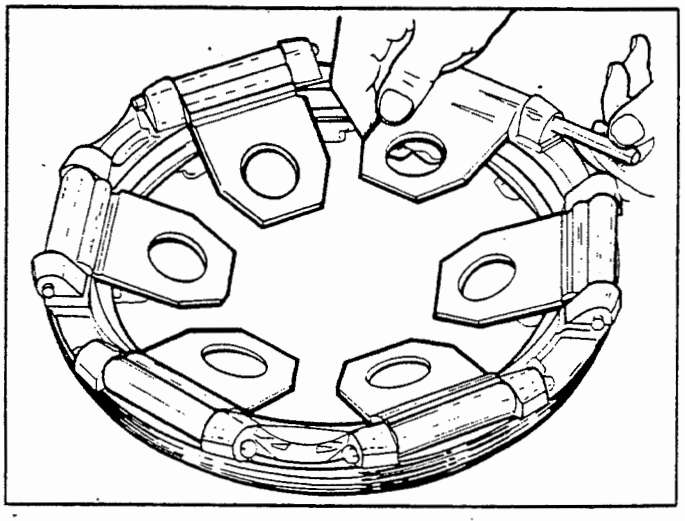


Figure 5-13. Remove Retainer Clips, Pins and Levers.

MC-9 MAINTENANCE MANUAL

INSPECTION

NOTE: All parts must be clean and dry for inspection.

1. Inspect release levers for excess wear at all points of contact with pressure plate, release sleeve retainer, and pivot pin. If levers are bent or worn, replace with new levers. It is good preventive maintenance to replace levers during clutch rebuild.
2. Inspect release sleeve retainer for wear in lever groove and internal splines. Refer to specifications for driving slot clearance between flywheel ring drive slots and release sleeve retainer drive lugs.
3. Inspect spring pivots for cracks; if visible, replace.
4. Check release sleeve subassembly bushing for excessive wear. Check bearing diameter for tight fit. Refer to specifications and replace if necessary.
5. We recommend replacing the release bearing and sleeve assembly as a unit at the time of clutch rebuild.
6. Check pivot pin holes in adjusting ring for wear. Clearance may not exceed .010" (.254 mm) between pin and hole. Inspect for cracks; replace if cracks are visible.
7. Inspect the flywheel ring for cracks. Replace if cracks are visible. Check slots for indentation caused by wear of pressure plate driving lugs. Note specifications for slot limits.
8. Inspect bolt circle face and pilot for nicks and burrs due to removal or handling. Remove burrs with file to ensure proper seating and squareness when clutch is mounted on flywheel.
9. Inspect fulcrum of pressure plate for wear. If wear exceeds .015" (.38 mm), remachine. See specifications for maximum rework.
10. Inspect friction surface of pressure plate for scoring, burning, heat checking or distortion. If friction surface is badly scored, heat checked, warped or dished in excess of .010" (.254 mm), resurface or replace with new pressure plate. Smooth and flat pressure plate surfaces are required for satisfactory clutch life.
11. Check drive lugs for wear per specifications.
12. Inspect friction surfaces of intermediate plate for heat checks, scoring or distortion as noted in the above paragraph. Inspect driving slots of intermediate plate for wear. See specifications.
13. Inspect disc assembly for cracks, loose rivets, worn splines, warped or dished condition. Straighten if dished or warped; .015" (.381 mm) maximum runout. Replace if hub is cracked or splines are worn excessively.
14. Replace facings if they are glazed, scored, worn down to rivet heads, burned, or if grease or oil is on them. Check specifications for proper thickness. Proper riveting is essential. Use a star set anvil to spread the rivet so it contacts the tapered counterbore of the facing. Do not use a roll or eyelet anvil (except with metallic facings).

ASSEMBLY

1. Place flywheel ring upside down on a table or workbench. Use a small paint brush and coat threads of adjusting ring and internal threads of flywheel ring with Darina EP-1 (figure 5-14).
2. Assemble adjusting ring to flywheel ring with "notches" down. Preset adjusting ring by placing two pivot pins in adjusting ring bosses directly opposite each other. Dimension from flywheel ring mounting surface to straight edge to be approximately 2-11/16" (68.3 mm) (figure 5-15).

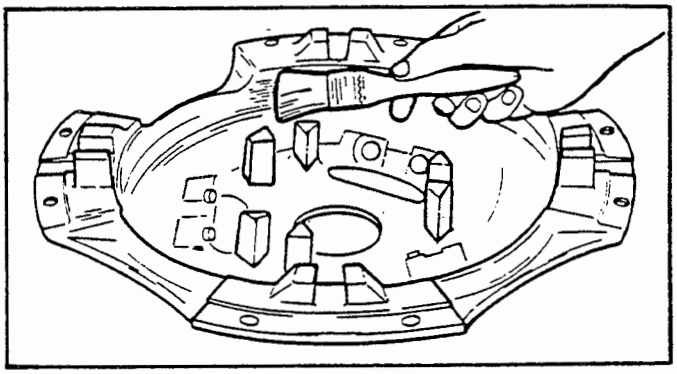


Figure 5-14. Coat Threads.

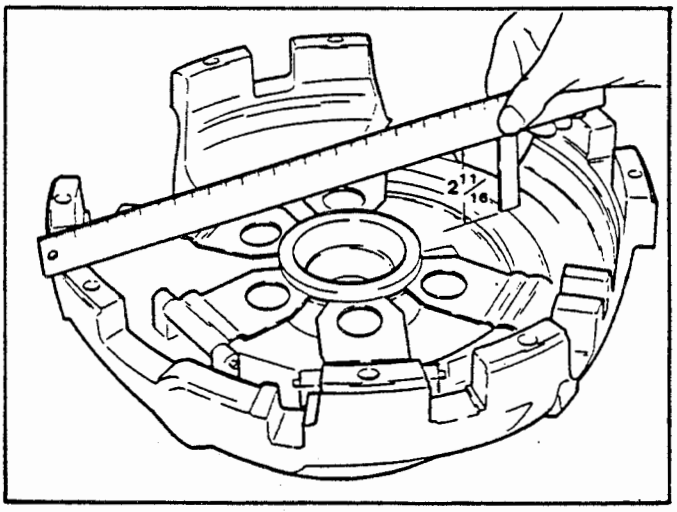


Figure 5-15. Adjusting Ring Dimensions.

3. Install three threaded rods in holes provided in flywheel ring. Place hex nut on opposite side of flywheel ring. Place spring pivots (F-4) on bosses in flywheel ring (C-1) and retainer (F-2) (figure 5-16).

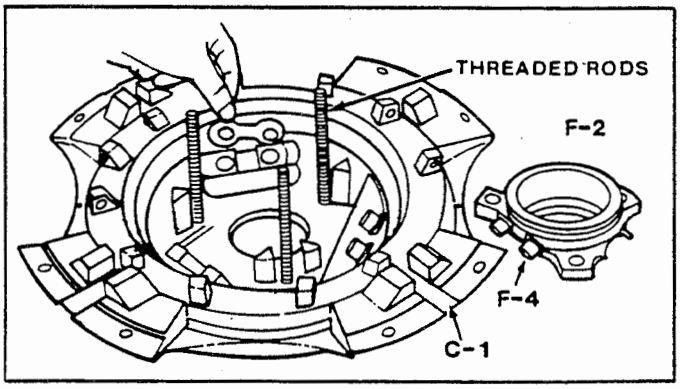


Figure 5-16. Install Spring Pivots.

MC-9 MAINTENANCE MANUAL

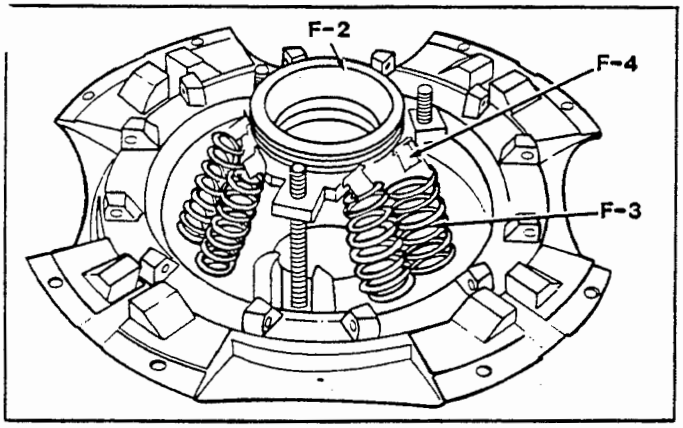


Figure 5-17. Install Release Sleeve Retainer.

4. Place release sleeve retainer (F-2) in position, guided on threaded rods. Install pressure springs (F-3) between spring pivots (F-4). Place hex nuts on three threaded rods and draw down enough to hold release sleeve retainer assembly in place (figure 5-17).

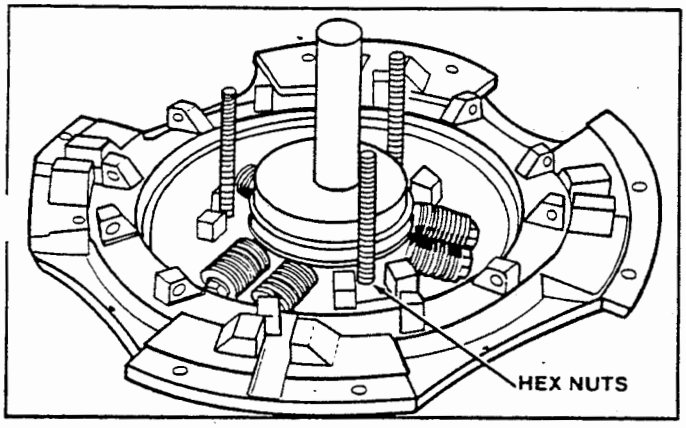


Figure 5-18. Depress Retainer.

5. Place flywheel ring and release sleeve retainer assembly on an arbor press and depress retainer until it bottoms against flywheel ring. Draw tightly three hex nuts on threaded rod against retainer (figure 5-18).

NOTE: Visually check pressure springs to assure seating on spring pivots.

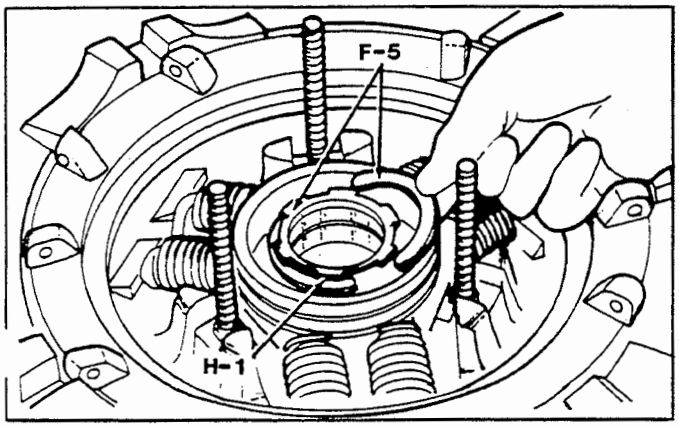


Figure 5-19. Install Half Ring Locks.

6. Install release sleeve and release bearing (G-1) assembly through flywheel ring and release sleeve retainer. Place half ring locks (F-5) in groove of release sleeve (figure 5-19).

7. Install ¾" (19 mm) wooden blocks between flywheel ring and release bearing housing. Place assembly on arbor press, supporting sleeve on 2½"-2¾" O.D. (6.35-69.9 mm) tubing. Compress retainer to relieve load on hex nuts. Remove threaded rods and release load against wooden blocks (figure 5-20).

NOTE: Do not support assembly on clutch release bearing cover rivet heads.

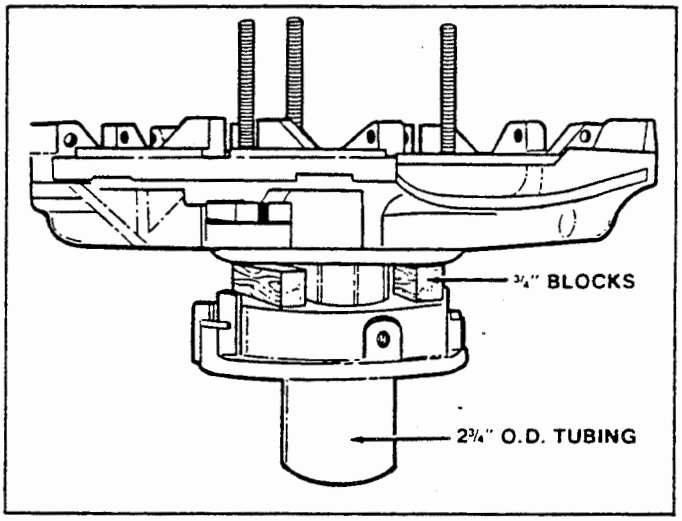


Figure 5-20. Install Wooden Blocks.

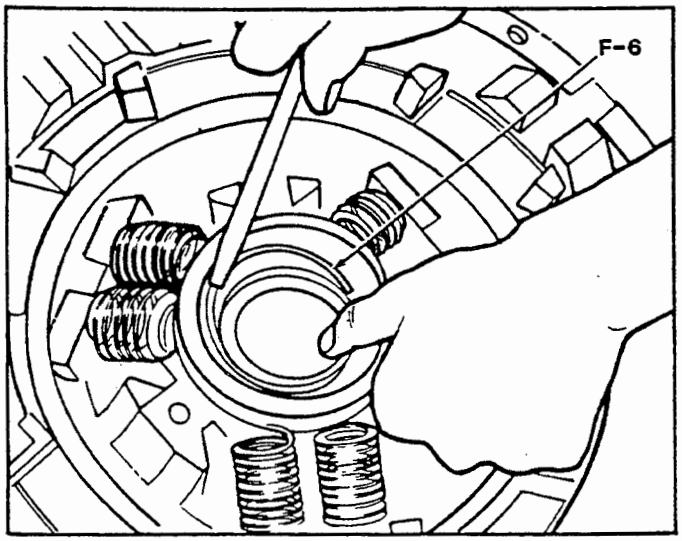


Figure 5-21. Install Retaining Ring.

8. Complete subassembly by placing retaining ring (F-6) in groove above the half-ring locks (figure 5-21).

MC-9 MAINTENANCE MANUAL

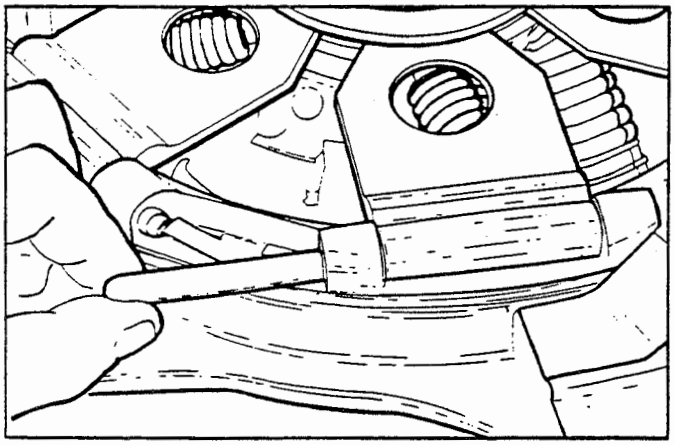


Figure 5-22. Insert Pivot Pins.

9. Return assembly to workbench and place levers between adjusting ring bosses with narrow end or "nose" in groove of release sleeve retainer. Lever fulcrum or raised area of lever must be facing pressure plate. Move adjusting ring either clockwise or counterclockwise as necessary to insert pivot pins. Return adjusting ring to previously set position (figure 5-22).

CAUTION: Spring clips must be installed so that one spring clip retains two pivot pins. Clips will only fit in every other opening because of casting interference.

10. Place retainer clip into position and insert pivot pin through clip hole into adjusting ring and lever holes until pin head snaps into position (figure 5-23).

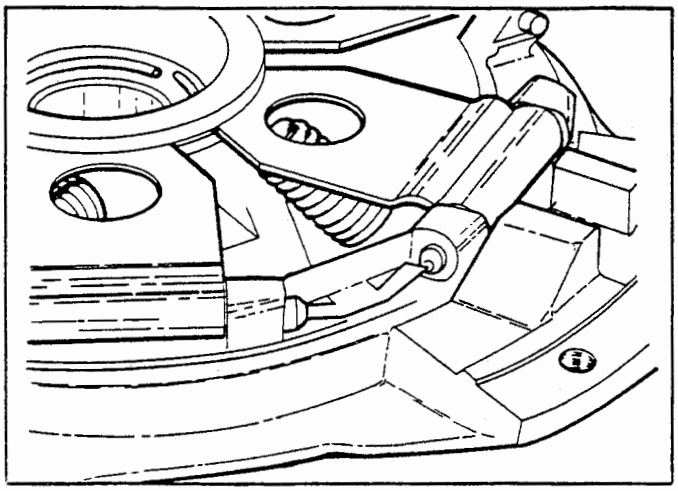


Figure 5-23. Install Retainer Clip.

11. Place pressure plate (B-1) in drive slots on flywheel ring. Check clearance between driving lugs on pressure plate and drive slots in flywheel ring (C-1). Clearance should be .004" to .008" (.102- 203 mm) (figure 5-24).

NOTE: Pressure plate was marked in relation to the flywheel ring when removed. Reassemble in same slot location.

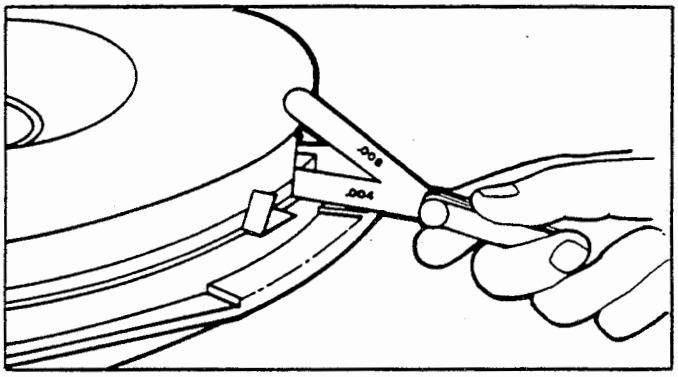


Figure 5-24. Check Driving Lug Clearance.

12. Install return springs (B-2) as shown. Make sure they are completely seated in hole (figure 5-25). Springs are to be hooked from inside of pressure plate first. Then hook opposite end from outside of flywheel ring.

13. Complete reassembly by turning assembly on pressure plate side and replace adjusting ring lock (D-2) and bolt assembly (D-3) (figure 5-26).

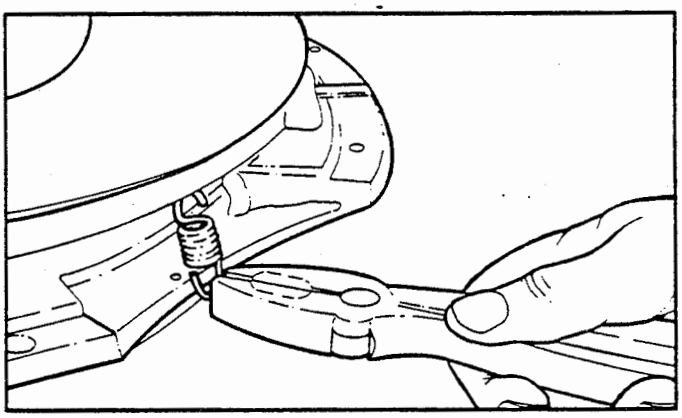


Figure 5-25. Install Return Springs.

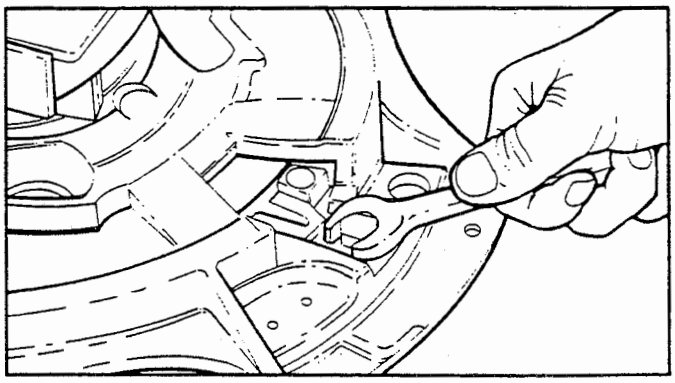


Figure 5-26. Replace Adjusting Ring Lock.

MC-9 MAINTENANCE MANUAL

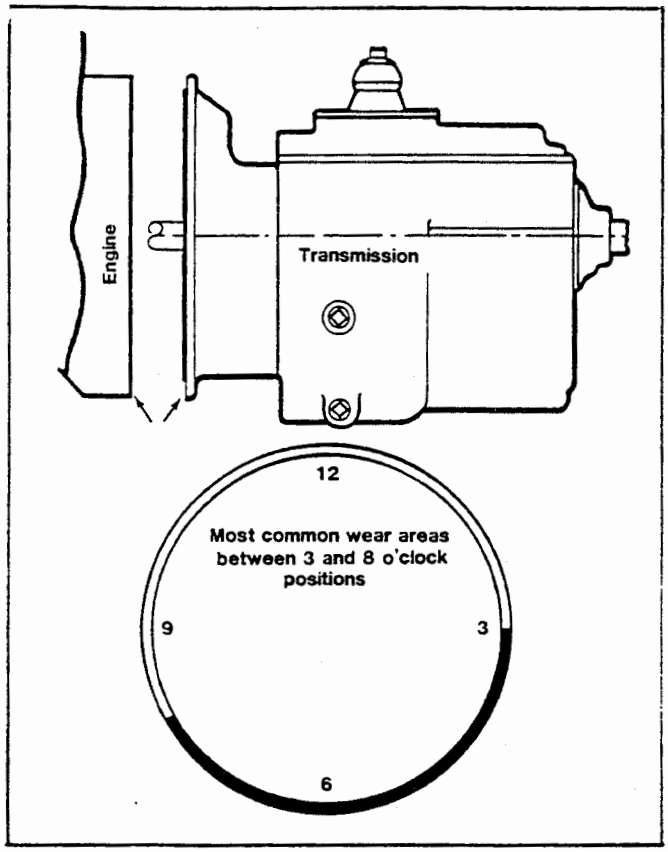


Figure 5-27. Housing Wear Areas.

ENGINE AND TRANSMISSION ALIGNMENT

The engine and transmission must line up. To check for this, make the following checks or measurements. Surfaces being gauged or measured must be clean for accurate measurements.

1. Inspect the mating faces of the transmission clutch housing and the engine flywheel housing (figure 5-27). Any appreciable wear on either housing will cause misalignment. Replace housing if worn. Most wear will be found on the lower half of the facings. Most common wear areas are between the 3 and 8 o'clock positions (figure 5-27).

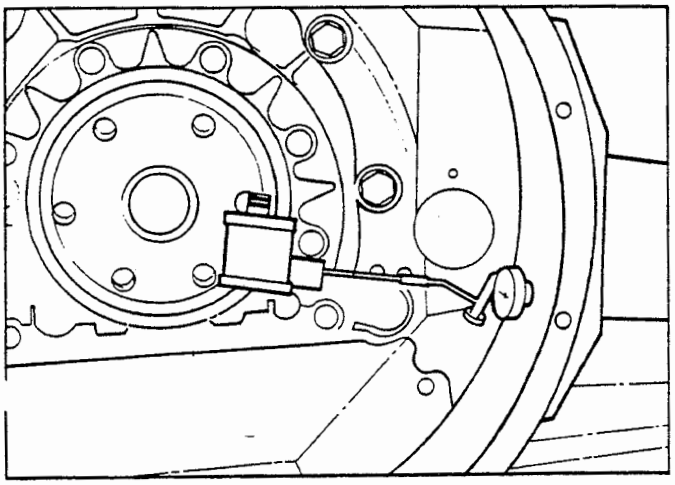


Figure 5-28. Checking Housing Pilot Runout.

2. With dial indicator secured to engine flywheel (figure 5-28) and gauge stylus against housing pilot, rotate flywheel by hand. With chalk or soapstone, mark high and low points. Total indicated difference between high and low points must be .008" (.203 mm) or less.

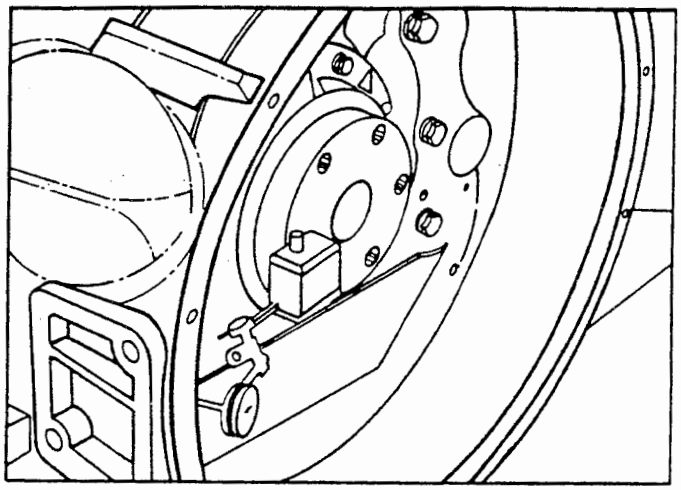


Figure 5-29. Flywheel Housing Face Runout.

3. Now move gauge stylus to contact face of engine flywheel housing (figure 5-29). Rotate flywheel and mark high and low points. Total runout should not exceed .008" (.203 mm).

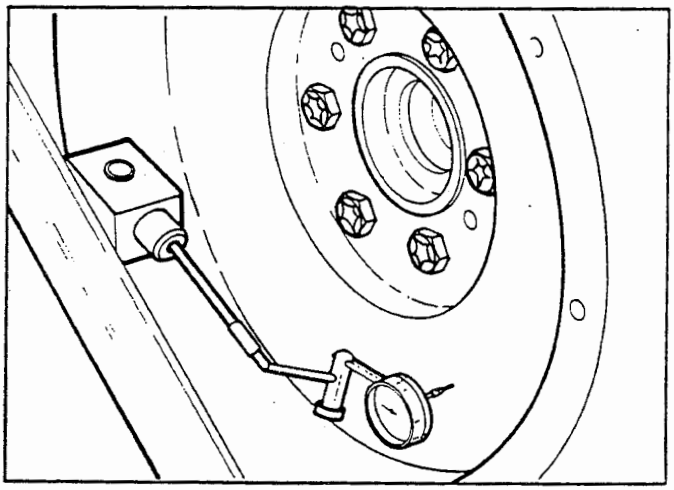


Figure 5-30. Flywheel Outer Edge Runout.

4. Next, secure dial indicator to engine flywheel housing with gauge stylus on face of flywheel near the outer edge (figure 5-30). Rotate flywheel. Maximum permissible runout is .0005" per inch of flywheel diameter. For instance, with a 15½" clutch, .0075" (.1905 mm) runout is allowable.

MC-9 MAINTENANCE MANUAL

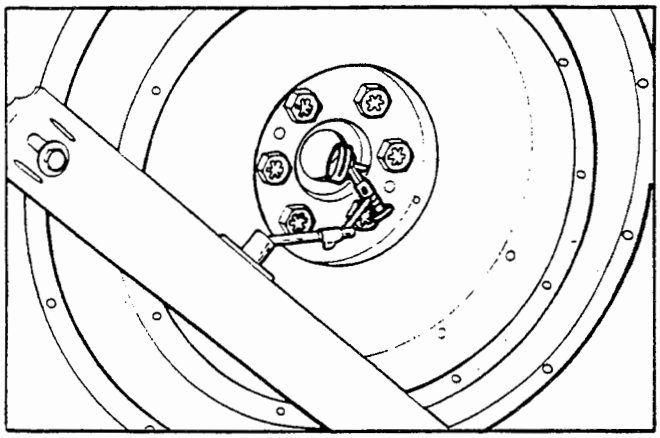


Figure 5-31 Pilot Bearing Bore Surface Runout.

5. Now move gauge stylus to contact pilot bearing bore surface (Figure 5-31). Rotate flywheel. Maximum total allowable runout is .005" (.127 mm).

If any of these limits are exceeded, the problem must be corrected or misalignment will cause premature wear to drive train components.

PRE-INSTALLATION CHECKS

Before installing the clutch, check the following items:

1. Inspect friction face of flywheel for smoothness, heat checks, scoring, excessive wear or runout on contact surface. The inspection for heat checks and scoring must be visual and based on experience; however, measure friction surface wear with straight edge and feelers. Replace or repair flywheel if wear is excessive. Refer to the manufacturer's recommendations concerning replacement or rebuilding.

2. If clutch is new, remove protective coating from pressure plate and intermediate plate.

3. A new pilot bearing should be used with a new or rebuilt clutch. If the old bearing is reused, clean and check the bearing thoroughly. Repack with lubricant.

4. If the flywheel has been replaced, always indicate the face and pilot diameters to make sure total indicator runouts are within engine manufacturer's specifications.

5. Check fit of splined hubs of front and rear friction discs by sliding on main drive gear spline of transmission. Hubs must slide free if clutch is expected to release cleanly and properly.

INSTALLING CLUTCH ON FLYWHEEL

1. Insert two 7/16"-14NC (5" (127 mm) long), guide studs into two upper mounting holes of the flywheel. Rotate flywheel if necessary to level guide studs.

2. Slide clutch disc aligning tool or drive gear stem through release bearing sleeve and assemble rear disc on tool.

3. Place intermediate plate in clutch cover assembly. Align driving lug of plate with slots provided. Assemble front disc on tool. See Figure 5-32 for proper location of driven discs.

4. Position clutch assembly under flywheel and use a small chain hoist or jack to lift clutch assembly into position on the two guide studs.

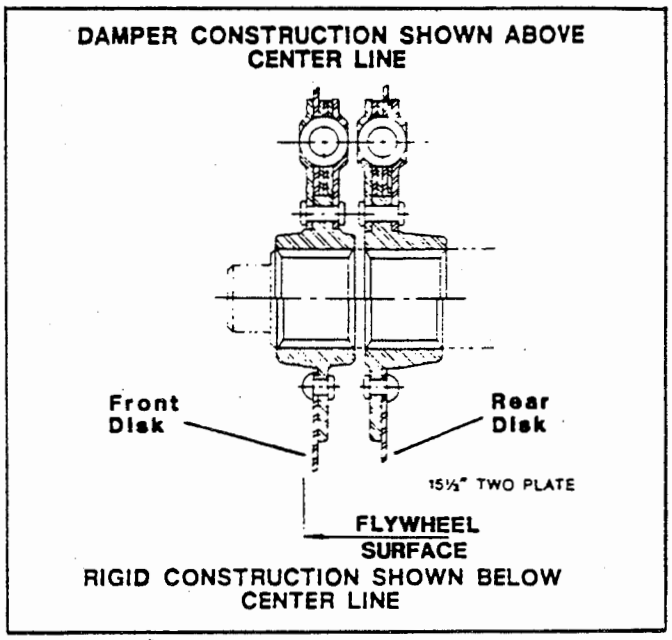


Figure 5-32. Clutch Plate Construction.

5. Slide clutch assembly forward and position in flywheel pilot. Start eight retaining capscrews with lock washers and run in finger tight. Tap clutch disc aligning tool to make sure it has entered and centered in pilot bearing.

6. Tighten the capscrews progressively and evenly to pull the clutch ring into its proper position in the flywheel pilot.

CAUTION: Don't try to pull the clutch into place by running one capscrew completely down with an impact wrench. This procedure can crack or break the pilot shoulders, causing eccentricity, off-square mounting and out-of-balance conditions.

7. Remove the two guide studs and insert two remaining capscrews and lock washers. For the final check, progressively tighten all capscrews to 35-40 ft. lbs. (47-54 Nm) torque.

8. As the capscrews are tightened, the ¾" wooden shipping blocks should fall free. If they don't, remove them at this time. Likewise, the final tightening will clamp the front and rear driven disc in position, so remove the clutch disc aligning tool at this time.

INSTALLATION OF TRANSMISSION TO CLUTCH AND ENGINE

1. Apply a light coating of anti-seize compound or high temperature grease to the sides and bottom of the main drive gear splines. This will help prevent rust, fretting, corrosion, etc. while the clutch is in service and afford easier transmission removal at a later date. Spread a small amount of grease inside the clutch release bearing.

CAUTION: Avoid the common practice of smearing a handful of grease over the splines of the drive gear. Most of this grease will be wiped off by the release bearing sleeve when the transmission is assembled to the clutch.

2. Always check wear on clutch release yoke fingers and replace the yoke if necessary.

3. Shift transmission into gear so that the main drive gear can be rotated during assembly to align with clutch driven disc hub splines.

4. Use a suitable sling or transmission jack to properly support and maintain engine/transmission alignment when installing the transmission. Raise transmission and position it square to, and aligned with, engine.

5. Rotate top of clutch release yoke (CR-7) rearward and center the yoke on drive gear bearing cap. Yoke must be held in this position during early part of assembly. Enter main drive gear into clutch release bearing sleeve (H-1). Slide transmission forward slowly to pick up driven disc splined hubs. It may be necessary to rotate companion flange slowly to align the splines of drive gear and clutch discs (figure 5-33).

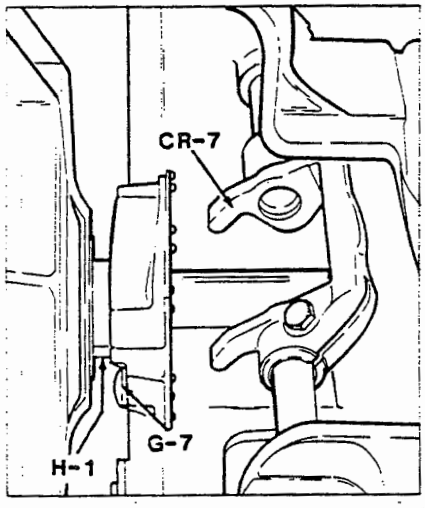


Figure 5-33. Yoke Position.

6. Observing through handhole opening in bell housing, make certain release bearing assembly is vertical with flat section on top and clutch release yoke fingers tipped up and centered to pass over release pads of release bearing assembly (figure 5-34).

CAUTION: Use care to avoid springing the driven discs when the transmission is being installed. Do not force the transmission into the clutch or flywheel housing if it resists. Don't let the transmission drop or hang unsupported by the driven discs.

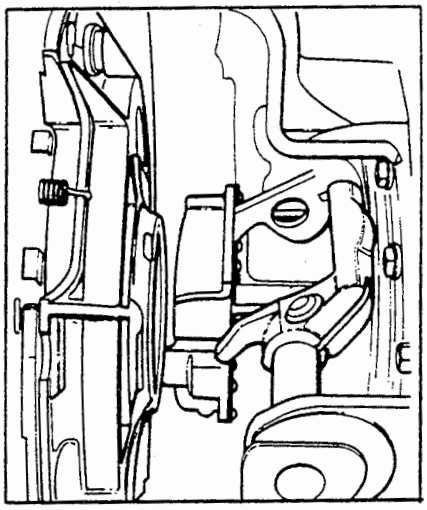


Figure 5-34. Check Release Bearing Assembly.

7. As soon as the fingers of the clutch release yoke pass the thrust pads of release bearing assembly turn the release shaft to swing the yoke fingers down in front of release pads (G-7) (figure 5-35).

8. Enter pilot of clutch housing into flywheel housing and align capscrew holes. Start all capscrews and tighten progressively around housing.

9. Connect clutch release linkage and check for proper free pedal, release bearing travel, clutch brake squeeze, etc., as outlined under clutch adjustment.

10. Readjust clutch and linkage, if required at this time. If new clutch facings were installed, it may be necessary to readjust clutch shortly after clutch is placed in service.

IMPORTANT: Interference with release yoke fingers by the clutch flywheel ring will prevent assembly of transmission or cause binding of release shaft if it is not rotated as shown in figure 5-35.

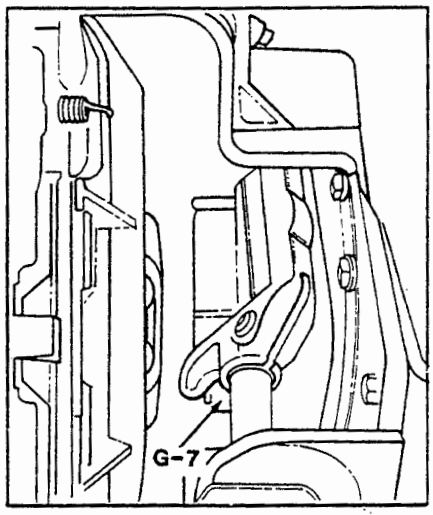


Figure 5-35. Swing Yoke Fingers Down.

MC-9 MAINTENANCE MANUAL

TORQUE-LIMITING CLUTCH BRAKE

The torque-limiting clutch brake (figure 5-36) helps lengthen the life of the transmission by aiding in smooth gear engagement at those times when the transmission gears may still be in motion even though the coach is stopped. Examples of this situation are (1) stopping at a traffic signal and immediately starting up again or (2) when shifting from first to reverse or from reverse to first gear.

The torque-limiting feature is provided by internal spring washers which are driven by a hub. The spring washers react against the clutch brake covers with facing material positioned between each spring washer and cover. The hub and spring washer combination slips with respect to the covers after approximately a 25 ft. lb. load has been exceeded.

Longer tang life is provided by the brake's ability to limit torsionally induced damage. Also, 5° of free play is provided between the hub and spring washers so that the inertia of the spring washers cannot load the hub directly. Inertia present in the covers is allowed to load the hub only up to the 25 to 30 ft. lb. load mentioned above. And, the tangs themselves are thicker to absorb what remaining torsionals do find their way to the hub.

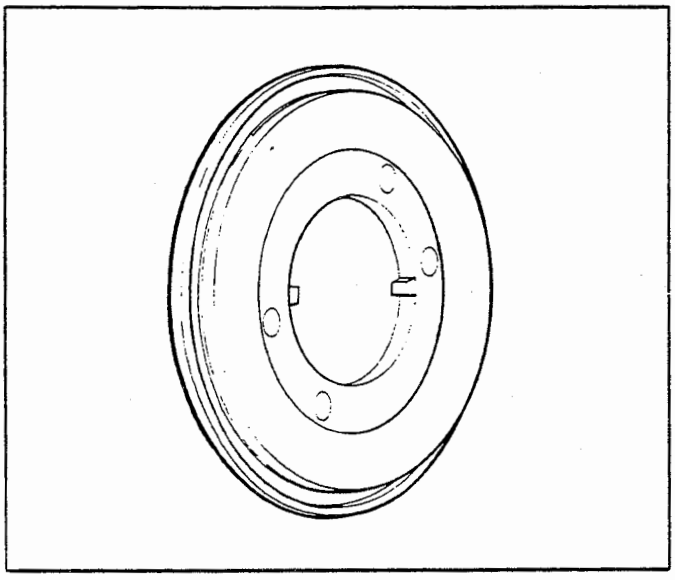


Figure 5-36. Clutch Brake.

There is no extra work on the driver's part to activate the brake. Depressing the clutch pedal to the floorboard, beyond thpe normal clutch disengage position, causes the clutch release bearing to come in contact with the clutch brake. Because the brake is splined to the transmission main drive gear (figure 5-37), the transmission is slowed down or stopped. The driver can then shift from first to reverse or from reverse to first without clashing or putting undue strain on the gears.

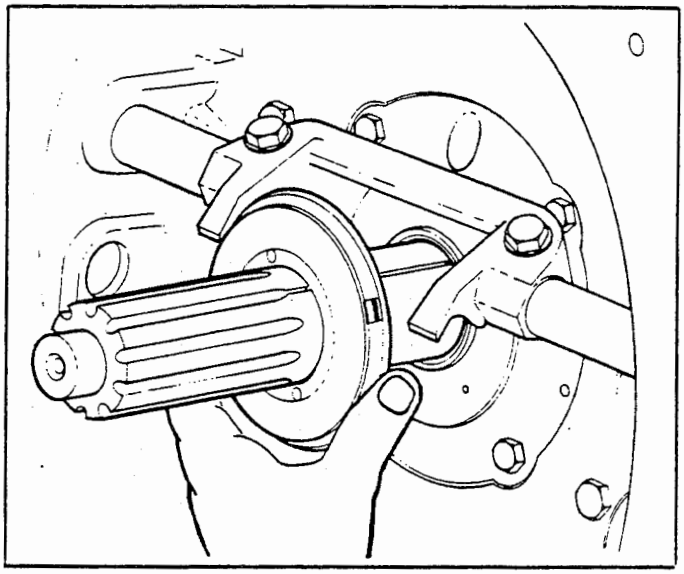


Figure 5-37. Clutch Brake Installed.

INSTALLATION

Install clutch brake before installing the transmission.

When used with Fuller Transmission equipped with standard bearing cap, clutch brake should be mounted with large facing diameter toward.transmission.

ADJUSTMENT

Clutch brake adjustment can be found in earlier pages of this section as part of the clutch adjustment procedure.

MC-9 MAINTENANCE MANUAL

LUBRICATION

Remove the handhold cover on the bottom of the clutch wheelhousing to gain access to clutch release bearing for lubrication. Only high-temperature grease should be used. Chassis lube or all-purpose lubricants are not recommended. Add lubricant at each chassis lubrication or more often if service is extreme.

WARNING: The release bearing housing has not been prepacked with grease. It must be lubricated when the clutch is installed in the coach. Otherwise, premature failure will occur.

RECOMMENDED LUBRICANTS:

SUPPLIER	PRODUCT
American Oil Co.	Amoco Lithium - M.P. Grease
Cities Service Co.	Citgo Premium Lithium Grease No. 2
Fiske Refining Co.	Lubriplate 630-2
Keystone Lubricating Co.	No. 81 Light
Mobil Oil	Mobilgrease M.P.
Shell Oil Co.	Retinax A
	Alvania No. 2
Atlantic Richfield Co.	Arco M.P.
Texaco	Multifak No. 2
Humble Oil Co.	Lidok 2
Chevron Oil Co.	Teknifax BRB-2, S.R.I.
	Teknifax BRB-2, S.R.I.

CLUTCH LIFE REMAINING

Many clutches are replaced as a preventive maintenance item at low mileage during repairs of the transmission or engine. Before the clutch assembly is replaced, it should be inspected for the following:

A. Heat cracks in the pressure plate.
B. Excessive wear in all drive slots.
C. Broken springs.
D. Dry or damaged release bearing.
E. Broken intermediate plate.
F. Excessive driven disc hub spline wear.
G. Burned facings.
H. Excessive wear on drive pins or intermediate plate slots.

If any of the above are not observed, the following graph (figure 5-36) can be applied to determine the approximate remaining clutch life by measuring the thickness of the rear driven disc assembly.

Find thickness of rear disc on column at left, then follow to curve on right and down to read percent of clutch life remaining.

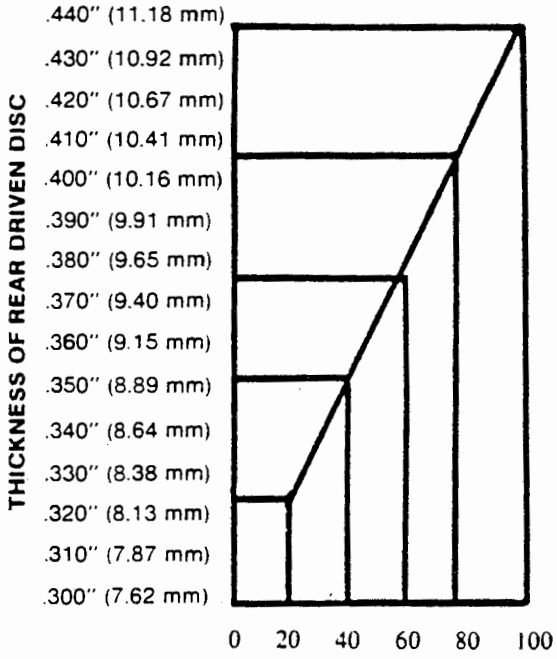


Figure 5-36. Percent of Clutch Life Remaining.

MC-9 MAINTENANCE MANUAL

CLUTCH TROUBLESHOOTING

TROUBLE	CAUSE
TOO MUCH FREE PEDAL	1. Check linkage for too much release travel.
NO FREE PEDAL	1. Ball not in retainer hole. 2. Broken or weak pedal return spring. 3. Adjusting spring not free to rotate. 4. Defective adjuster assembly. 5. Check release travel - must be ½" (12.7 mm) plus about ⅛" (3.175 mm) free travel. Short travel linkage will not work with this mechanism. 6. Clutch brake adjusted too high. Should be adjusted 1" (25.4 mm) from end of stroke. 7. Total clutch adjustment has been taken up. (Remove and replace clutch.)
POOR RELEASE	
1. Pressure plate not retracting.	a. Check pressure plate drive lugs for proper clearance of .006" min. (.152 mm). b. Check pressure plate return springs are bent or stretched. c. Replace if necessary. d. Insufficient release travel. e. Lever nose out of groove in release sleeve retainer.
2. Driven disc distorted or warped.	a. Driven disc assembly must be straight within .015" (.381 mm) total indicator reading. Replace discs if they can't be straightened. b. Damage to driven discs can be caused by poor installation methods. Do not force transmission drive gear into disc hubs. This will distort or bend driven discs causing poor release.
3. Splines worn on main drive gear of transmission.	a. Replace drive gear and check driven disc hubs for excessive wear. If worn, replace disc. Check flywheel housing alignment of engine and transmission. Make sure driven discs slide freely on drive gear splines. b. Check pressure plate drive lugs for proper clearance of .006" min. (.152 mm).
4. Internal clutch adjustment not correct	a. Readjust clutch for standard release travel. Refer to adjusting instruction. b. Proper clutch adjustment must be maintained for proper clutch release.
5. Flywheel pilot bearing fitting too tightly in flywheel or on end of driven gear.	a. Free pilot bearing to a light push. b. Fit in flywheel and on drive gear pilot. c. If gearing is rough, replace.
6. Facings gummed with oil or grease.	a. Replace facings or entire driven disc assembly b. Cleaning not recommended.
7. Damaged clutch release bearing.	a. Replace bearing. b. If bearing is grease type, lubricate.
8. Clutch release shaft projecting through release yoke.	a. Relocate shaft so it does not project. b. Check all housing bushings and release yoke for wear.
9. Release yoke contacting cover assembly at full release position.	a. Replace release yoke with proper yoke.
10. Release yoke will not align with release bearing properly.	a. Flywheel has been resurfaced more than recommended .060" (1.524 mm) removal.
CLUTCH SLIPPAGE	
1. Weak pressure springs.	a. Replace springs.
2. No free pedal.	a. Readjust clutch. b. Refer to adjustment instructions.

MC-9 MAINTENANCE MANUAL

CLUTCH TROUBLESHOOTING (Cont'd)

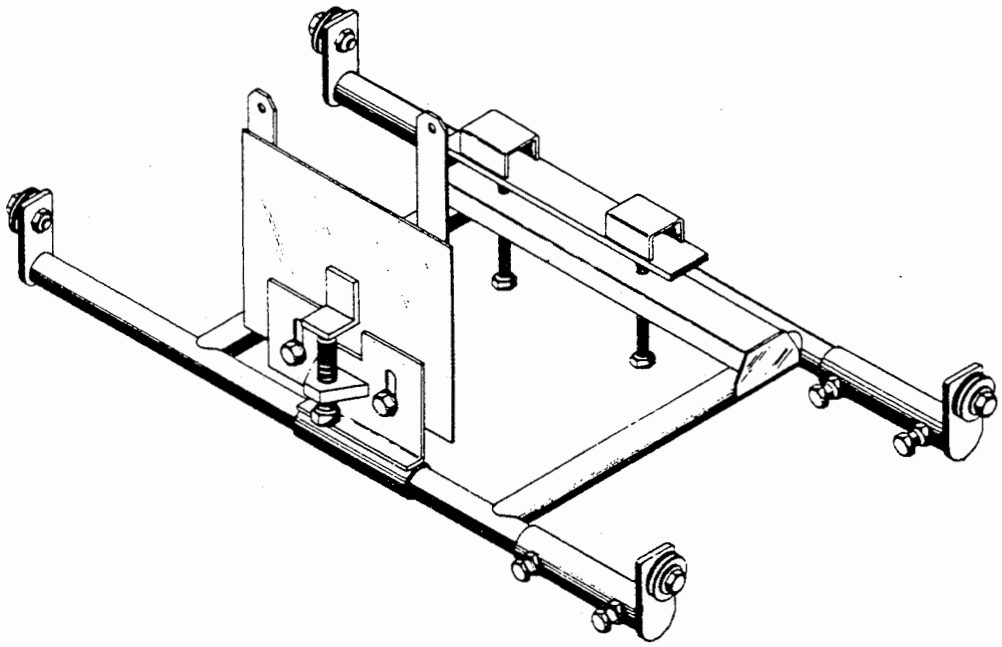
TROUBLE	CAUSE
NOISY CLUTCH	
1. Clutch release bearings dry or damaged.	a. Lubricate bearing, or replace.
2. Flywheel pilot bearing dry or damaged.	a. Lubricate bearing or replace.
3. Clutch release bearing housing striking flywheel ring.	a. Adjust clutch. b. Refer to adjustment instructions. c. Also check wear on cross shafts, bell housing bushings and release yoke fingers. If badly worn, replace parts.
4. Excessive clearance between drive slots and drive lugs on intermediate and pressure plates.	a. Check clearance as noted on wear limits. If above limits, replace parts.
3. Worn clutch facings.	a. Replace facings or complete driven disc assembly.
4. Release mechanism binds.	a Free up mechanism and linkage, check clutch adjustment. b. Refer to adjustment instructions.
5. Grease or oil on facings.	a. Replace facings or complete driven disc assembly.

CLUTCH SPECIFICATIONS

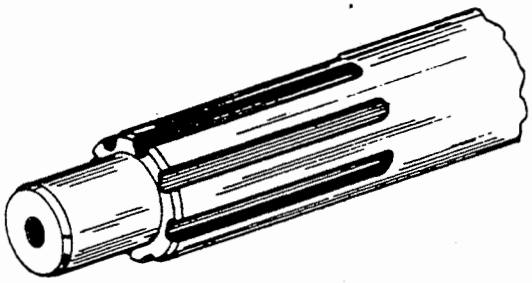
Manufacturer	Dana
Type	Dry 2-Plate, Pull Type
Size	15½"
Disc and Facing Thickness - standard	.487/.452" (12.4/11.5 mm)
Hub Spline Size (inches/no. splines)	2-10
Disc Assembly Max Runout (T.I.R.)	.015" (.381 mm)
Disc Assembly Max Out-of-Flat	.020" (.508 mm)
Release Sleeve	1.754/1.750" (44.552/44.45 mm)
Bushing Diameter (new)	2.010/2.008" (51.054/51.003 mm)
Intermediate Plates, driving lugs to slot clearance (new, min.)	.006" (.152 mm)
(max. worn)	.015" to .021" (.381 mm to .533 mm)
Pressure Plates, driving lugs to slot clearance (new)	.003" to .010" (.076 to .254 mm)
Pressure Plates, driving lugs to slot clearance (max. worn)	.016" to .021" (.406 to .533 mm)
Intermediate Plates and Pressure Plates	.000 to .004" (.000 to .102 mm)
Out-of-Flat	.004" (.102 mm) Concave
Scoring - Max. depth that can be reused	.015" (.381 mm)
Regrind - Max. removal per side	.015" (.381 mm)
Fulcrum Wear (Max.) rework	.030" (.762 mm)
Release Sleeve Retainer, driving lugs to slot clearance (max. worn)	.020" (.508 mm)
Clutch Plate Load	2800 lbs (1270 kg)

MC-9 MAINTENANCE MANUAL

SERVICE TOOLS



20-233 5-SPEED MANUAL TRANSMISSION DOLLY



20-40 ALIGNMENT TOOL- (Clutch to Main Bearing Bore)

Date 1-1-89.

MC-9 MAINTENANCE MANUAL

SECTION 6

COOLING SYSTEM

Alarmstats 6-11
Antifreeze 6-3
Blower Belt Air Cylinder 6-15
Blower Gear Box 6-13
Cold Weather Operations 6-2
Coolant Filters - General 6-5
Coolant Filter - Spin-On (Optional) 6-8
Coolant Recovery System 6-10
Coolant Requirements 6-3
Corrosion Inhibitors 6-4
Draining Cooling System 6-7
Filling Cooling System 6-8
Hose Inspection 6-2
Preventive Maintenance 6-2
Radiators 6-11
Service Tools 6-19
Shutters and Shutterstats 6-11
Shutterstat Air Filter 6-12
Silicate Dropout 6-5
Specifications 6-18
Temperature Control Components 6-1
Testing Antifreeze Solutions 6-2
Water 6-3
Water Pump Seal 6-11
Service Bulletin Page

MC-9 MAINTENANCE MANUAL

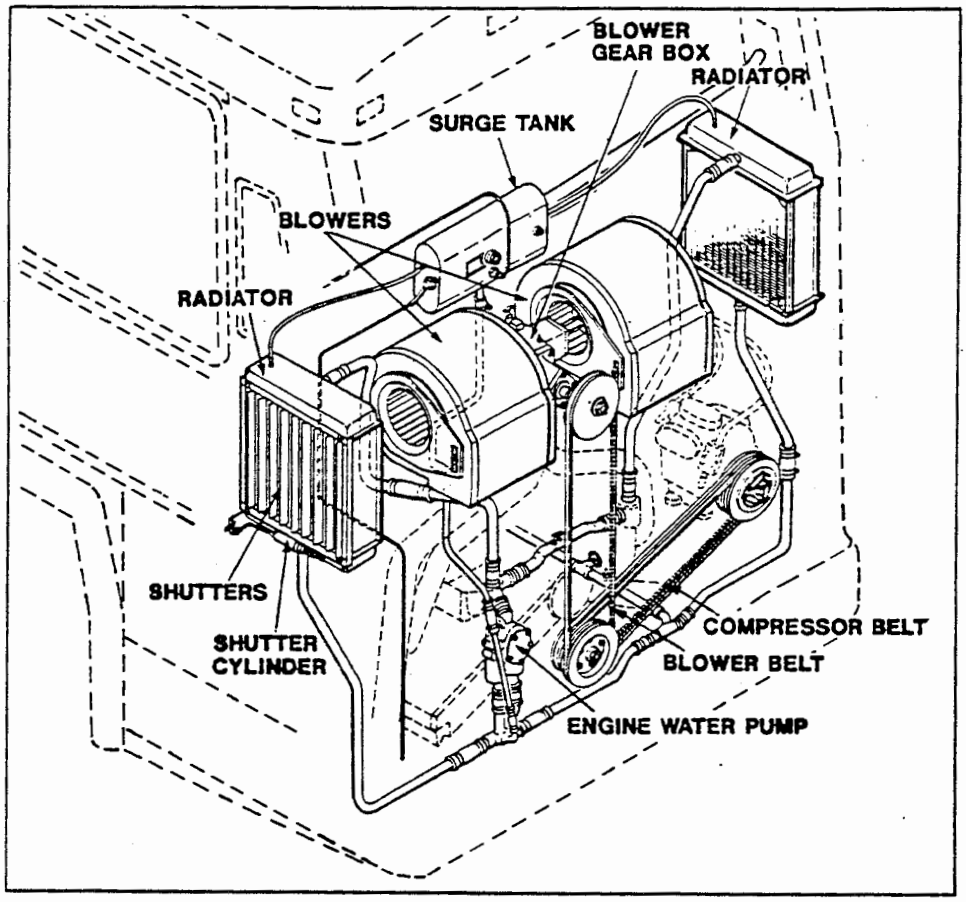


Figure 6-1. Cooling System Components.

COOLING SYSTEM

One radiator is mounted on each side of the coach above the engine. Cores are of fin and tube construction. Dual centrifugal blowers are belt driven from the engine crankshaft through a gear box. They pull outside air through the radiators into a sealed, insulated blower compartment when the air operated, thermostatically controlled shutters are open.

When engine coolant is below normal operating temperature the shutters are automatically closed. With shutters closed, no air is pulled across the radiators and horsepower required to drive the centrifugal blower becomes significantly reduced.

The blower gear box includes a sight gauge for checking lubricant level and an easily accessible oil filler tube. Belt tension is maintained through an automatic, air controlled belt tightener.

The surge tank is mounted in the upper blower compartment. The coolant filler neck and pressure release valve are mounted behind the access door on the right rear side of the coach. A coolant level check can be done rapidly by means of a sight glass installed on the surge tank. Thermostats and alarmstats are provided at the front of each cylinder head.

The function of the coolant is to absorb the heat which develops as a result of the combustion process in the engine. In addition, the heat absorbed by the oil is removed by the engine coolant in the oil cooler.

The engine water pump circulates coolant through the engine oil cooler, block, cylinder heads and aftercooler. From the aftercooler it flows through the thermostats to the radiators and down to the water pump completing the cycle. Anything that interferes with this process of heat transfer can cause engine components to overheat, often resulting in serious engine damage. See figure 6-1.

COOLANT TEMPERATURE

The heat-dissipating capacity of the V-92 Series engine cooling system and related components must be sufficient to prevent the coolant-out temperature from rising above the maximum allowable coolant-out temperature limit of 210°F (98.9°C).

This temperature must not be exceeded under any engine operating conditions, regardless of altitude, type of coolant used, or cooling system condition. Exceeding these limits can result in malfunction or serious engine damage.

TEMPERATURE CONTROL COMPONENTS

The engine is designed to operate with thermostats which, combined with a radiator, regulate coolant temperature. Radiator shutters, and fans, are used to help control coolant temperature. These "add on" cooling system components

must operate in proper sequence to prevent coolant temperature instability and/or engine overheating. An improper operating sequence can also have a detrimental effect on the life of the "add on" components as well.

The following chart gives the **nominal** temperature settings for the 180°F (82°C) thermostat and shutterstat controls, along with standard and optional alarmstat settings. These settings should not be exceeded, under any engine operating condition, regardless of operating altitude, type of coolant used, or cooling system condition. Exceeding the settings will unnecessarily increase the engine coolant and lubricating oil temperature.

NOTE: Coolant temperature instability will result from improper component operating sequence.

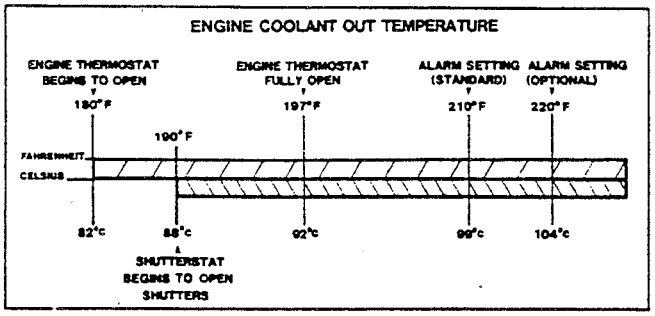


Figure 6-2. Nominal Settings For Coolant Temperature Controls.

The major components of the cooling system are the coolant, radiators, blower gear box and surge tank. These components, as well as the minor ones, are covered in more detail later in this section.

HOSE INSPECTION

Swollen, cracked or worn out hoses or loose hose connections are frequent causes of cooling system problems.

Serious overheating is often caused by old hose collapsing or from deteriorated rubber shedding from hoses and clogging the coolant passages.

Connections should be inspected periodically and hose clamps tightened. Replace any hose found to be cracked or swollen. When installing a new hose, clean pipe connections and apply a thin layer of a non-hardening sealing compound. Replace worn out clamps or clamps that pinch hoses.

TESTING ANTIFREEZE SOLUTIONS

Always test solution before adding water or antifreeze. Engine should be warmed to operating temperature. Fill and empty tester several times before using, and ensure that tester is clean inside and out.

If a coolant filter is used, replace the element every 500 hours or 20,000 miles (32,000 km).

Commercial cooling system cleaners of alkaline or acid type may be used. Exercise extreme caution and follow the manufacturer's recommendations when using these types of cleaners.

Problems may develop from leaks and seepage at the engine water pump and thermostat housings hose connections. These may be caused by deformation and rough surfaces on the castings at the hose mounting surfaces. It is recommended that Dow Corning RTV-102 Compound be applied to cast surfaces prior to hose installation.

CAUTION: Castings should be clean and free of oil and grease before applying compound. No other sealer should be used with RTV compound.

COLD WEATHER OPERATIONS

Although not recommended, plain water with an inhibitor may be used as a coolant where temperatures do not reach below 32°F (0°C). In colder regions antifreeze must be used.

Before adding antifreeze the cooling system should be inspected for winter operation. Cylinder head gaskets should be tightened or replaced where necessary to avoid the possibility of coolant leaking into engine and exhaust gases blowing into cooling system.

After antifreeze has been added, the entire system should be inspected regularly to ensure against the development of leaks.

If the cooling system becomes frozen, place the coach in a warm area until the ice is completely thawed. Under no circumstances should the engine be operated when the cooling system is frozen.

PREVENTIVE MAINTENANCE

A program of maintenance of the cooling system components is essential to ensure maximum system efficiency, and trouble-free operation. Observe the following guidelines:

1. Check, on a daily basis, the coolant level in the surge tank. Keep tank filled with the coolant required for proper operation in the extremes of seasonal temperatures.

2. Every 20,000 miles (32,000 km) perform the following checks:

a. Check belts for condition and tension. Tighten loose belts and replace those frayed or worn.

b. Check water pump operation and installation. A leaking pump will suck air into the cooling system, causing corrosion of engine and cooling system components, and decreasing the efficiency of the coolant. Correct all leaks at once.

c. Check the radiators and all hoses for leaks. Repair leaking components. Clean the radiator cores with low pressure air to remove all dirt and thus provide optimum heat dissipation. Check and tighten radiator mounts as required. Repair all leaks.

d. If a coolant filter is used, replace the element at this interval.

3. The following procedures are necessary every 100,000 miles (161,000 km):

a. Check the strength of the antifreeze with a hydrometer. If too weak, drain a quantity of coolant from the system, and replace with the same quantity of coolant (water/antifreeze mixture) in proper proportion to result in correct overall solution strength.

b. Check the strength of the inhibitor in the coolant. Use a test kit or strip made available by the manufacturer of the inhibitor in use. Follow the instructions of the inhibitor manufacturer. Add inhibitor only in the amount necessary to reach manufacturer's strength recommendations.

MC-9 MAINTENANCE MANUAL

NOTE: Specific instructions are set forth below concerning coolant requirements, antifreeze, use of water in the system, corrosion inhibitors, silicate gel formation and coolant testing.

COOLANT REQUIREMENTS

Coolant solutions must meet the following basic requirements:

1. Provide for adequate heat transfer.
2. Provide a corrosion-resistant environment within the cooling system.
3. Prevent formation of scale or sludge deposits in the cooling system. Figure 6-3 contains water quality data.
4. Be compatible with cooling system hose and seal materials.
5. Provide adequate freeze protection during cold weather operation and boil-over protection in hot weather.

The first four requirements are satisfied by combining a suitable water with reliable inhibitors. When freeze protection is required, a solution of suitable water and an antifreeze containing adequate inhibitors will provide a satisfactory coolant. Ethylene glycol-based antifreeze solutions are recommended for year-round use.

WATER

Whether of drinking quality or not, any water will produce a corrosive environment in the cooling system, and the mineral content may permit scale deposits to form on internal cooling system surfaces. Therefore, water selected as a coolent must be properly treated with inhibitors to control corrosion and scale deposition.

To determine if a particular water is suitable for use as a coolant when properly inhibited, the following characteristics must be considered: the concentration of chlorides and sulfates, total hardness, and total dissolved solids.

Chlorides and/or sulfates tend to accelerate corrosion, while hardness (percentage of magnesium and calcium salts broadly classified as carbonates) cause deposits of scale. Total dissolved solids may cause scale deposits, sludge deposits, corrosion, or a combination of any of these. Chlorides, sulfates, magnesium and calcium are among the materials which make up dissolved solids. Water within the limits specified in Table 1 (figure 6-3) is satisfactory as an engine coolant when proper inhibitors are added. The procedure for evaluating water intended for use in a coolant solution is shown in Table 2.

TABLE 1

	PARTS PER MILLION	GRAINS PER GALLON*
Chloride (Maximum)	40	2.5
Sulfates (Maximum)	100	5.8
Total Dissolved Solids (Maximum)	340	20
Total Hardness (Maximum)	170	10

Refer to Table 2 for evaluation of water intended for use in a coolant solution.

*4.5 liters

TABLE 2

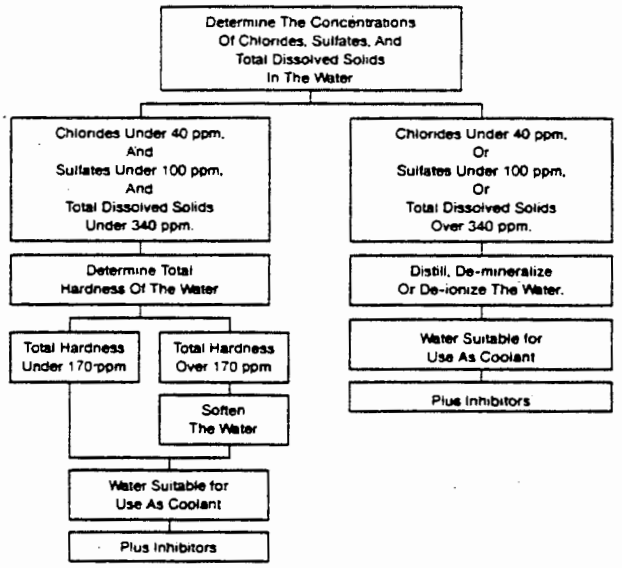

Determine The Concentrations Of Chlorides, Sulfates, And Total Dissolved Solids In The Water
Chlorides Under 40 ppm, And Sulfates Under 100 ppm, And Total Dissolved Solids Under 340 ppm.
Chlorides Under 40 ppm, Or Sulfates Under 100 ppm, Or Total Dissolved Solids Over 340 ppm.
Determine Total Hardness Of The Water
Distill, De-mineralize Or De-ionize The Water.
Total Hardness Under 170 ppm
Total Hardness Over 170 ppm
Water Suitable for Use As Coolant
Plus Inhibitors
Soften The Water
Water Suitable for Use As Coolant
Plus Inhibitors

Figure 6-3. Cooling Fluid Characteristics.

ANTIFREEZE

When freeze protection is required, use an antifreeze that meets the GM 6038M formulation, which limits silicate to 0.15% maximum, or an equivalent formulation meeting the 0.15% maximum silicate and GM 1899M performance requirements.

Solutions of less than 30% do not provide adequate corrosion protection. Concentrations over 67% adversely affect freeze protection, heat transfer rates, and silicate stability. A 50% antifreeze solution is normally used as factory-fill.

Ethylene glycol base antifreeze is recommended. Methyl alcohol base antifreeze is not recommended because of its effect on the non-metallic components of the cooling system and because of its low boiling point. Methoxy propanol base antifreeze is not recommended due to the presence of fluoroelastomer seals in the cooling system.

The inhibitors in antifreeze solutions should be replenished with a non-chromate corrosion inhibitor supplement when indicated by testing the coolant. Engine coolant should be checked at approximately 500 hour or 20,000 mile intervals. (See Coolant Testing, below.)

Antifreeze solutions should be used year-round to provide freeze protection in the winter, boil-over protection in the summer, and a stable environment for seals and hoses in the cooling system of the engine. (See figure 6-4.)

MC-9 MAINTENANCE MANUAL

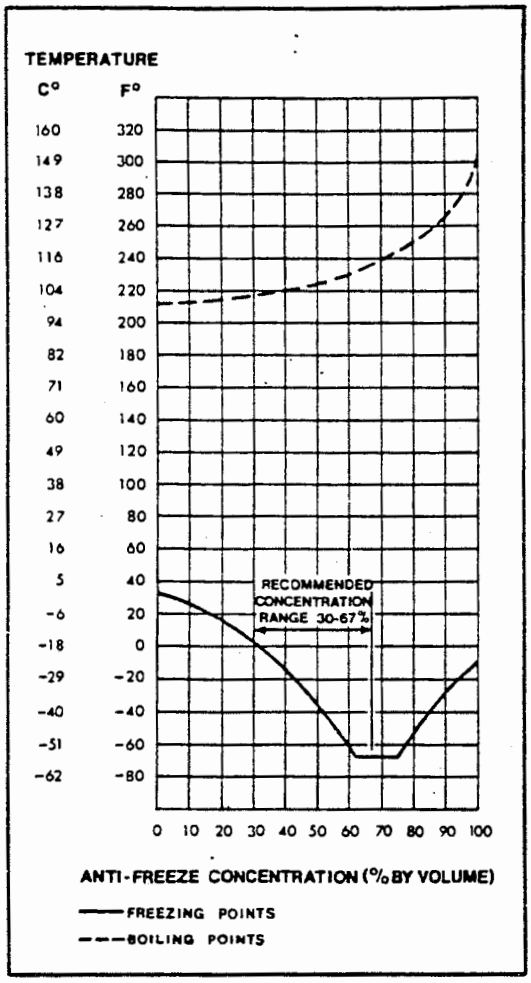


Figure 6-4. Freezing and Boiling Temperatures of Coolant (at sea level).

CORROSION INHIBITORS

A corrosion inhibitor is a water-soluble chemical compound which protects the metallic surfaces of the cooling system against corrosive attack. Some of the more commonly used corrosion inhibitors are chromates, borates, nitrates, nitrites, and soluble oil. *(Soluble oil is not recommended as a corrosion inhibitor.)* Depletion of all types of inhibitors occurs through normal operation. Therefore, strength levels must be maintained by adding inhibitors as required after testing the coolant.

The importance of a properly inhibited coolant cannot be overstressed. A coolant which has insufficient inhibitors, the wrong inhibitors, or — worse — no inhibitors at all invites the formation of rust and scale deposits within the cooling system. Rust, scale, and mineral deposits can wear out water pump seals and coat the walls of the cylinder block water jackets and the outside walls of the cylinder liners. As these deposits build up, they insulate the metal and reduce the rate of heat transfer. For example, a 1/16" deposit of rust or scale on 1" of cast iron is equivalent to 4¼" of cast iron in heat transferability.

An engine affected in this manner overheats gradually — over a period of weeks or months. Liner scuffing, scoring, piston seizure, and cylinder head cracking are the inevitable results. An improperly inhibited coolant can also become corrosive enough to "eat away" coolant passages and seal ring grooves and cause coolant leaks to develop. If sufficient coolant accumulates on top of a piston, a hydrostatic lock can occur while the engine is being started. This, in turn, can result in a bent connecting rod.

An improperly inhibited coolant can also contribute to *cavitation erosion.* Cavitation erosion is caused by the collapse of bubbles (vapor pockets) formed at the coolant side of an engine component. The collapse results from a pressure differential in the liquid caused by the vibration of the engine part. As bubbles collapse, they form pin points of very high pressure. Over a period of time, the rapid succession of millions of tiny bursting bubbles can wear away (erode) internal engine surfaces.

Components such as fresh water pump impellers and cylinder liners are especially susceptible to cavitation erosion. In extreme cases their surfaces can become so deeply pitted that they appear to be spongy, and holes can develop completely through them.

NON-CHROMATES — Non-chromate inhibitors (borates, nitrates, nitrites, etc.) provide corrosion protection in the cooling system with the basic advantage that they can be used with either a water or water-and-antifreeze solution.

CHROMATES — Sodium chromate and potassium dichromate are two of the most commonly used water system corrosion inhibitors. Care should be exercised in handling these materials due to their toxic nature.

Chromate inhibitors *should not be used in antifreeze* solutions. Chromium hydroxide, commonly called "green slime," can result from the use of chromate inhibitors with antifreeze. This material deposits on the cooling system passages, reducing the heat transfer rate and resulting in engine overheating. Engines which have operated with a chromate-inhibited water must be chemically cleaned before the addition of antifreeze. A commercial heavy-duty descaler should be used in accordance with the manufacturer's recommendation for this purpose.

SOLUBLE OIL — *Soluble oil is not recommended as a corrosion inhibitor.* It has been used as a corrosion inhibitor for many years. It has, however, required very close attention relative to the concentration level due to adverse effects on heat transfer if the concentration exceeds 1% by volume. For example, 1.25% of soluble oil in the cooling system increases fire deck temperature 6%, and 2.50% concentration raises fire deck temperature up to 15%.

INHIBITOR SYSTEMS AND ADDITIVES — An inhibitor system is a combination of chemical compounds which provide corrosion protection, pH control, and water-softening ability. pH control is used to maintain an acid-free solution. The water-softening ability deters formation of mineral deposits. Inhibitor systems are available in various forms, such as coolant filter elements, liquid and dry inhibitor additives, and as integral parts of antifreeze.

Commercially packaged inhibitor systems are available which can be added directly to the engine coolant. Both chromate and non-chromate systems are available, and care should be taken regarding inhibitor compatibility with other coolant constituents.

Non-chromate inhibitor systems are recommended. These systems can be used with either water or water-and-antifreeze solutions and provide corrosion protection, pH control, and water softening. Most non-chromate inhibitor systems offer the additional advantage of a simple on-site test to determine protection level. Since they are added directly to the coolant, they

equire no additional hardware or plumbing.

All inhibitors become depleted through normal operation, and additional inhibitor must be added to the coolant as required to maintain original strength levels.

NOTE: Over-inhibiting antifreeze solutions can cause silicate dropout. Always follow the supplier's recommendations on inhibitor usage and handling.

SILICATE DROPOUT

Excessive amounts of chemicals in the engine coolant can cause silicate dropout, which creates a gel-type deposit that reduces heat transfer and coolant flow. Silicate dropout may also occur in coolants using extremely hard water and/or unusually high operating temperatures.

The gel takes on the color of the coolant solution in the wet state but appears as a white powdery deposit when dry. Although silica gel is non-abrasive, it can pick up solid particles in the coolant and become a gritty, abrasive deposit that can cause excessive wear of water pump seals and other cooling system components.

If it is suspected that a coach cooling system has a gelling problem (indicated by engine overheating or coach underheating), first try to remove the gel in its "wet" condition. Use an alkaline cleaner (Nalprep 2001 or equivalent) as directed by the manufacturer, so that the silica-gel is not allowed to dry. If using the cleaner once does not correct it, repeat the procedure. If available, ultrasonics is another process that can be used to remove the gel without damage to cooling system components.

If silica-gel has been allowed to dry inside a cooling system component, removing the gel becomes more difficult. The gel tends to form in low areas of the cooling system, i.e., radiator bottom tank or areas within the engine oil cooler. If gel can be reached for mechanical cleaning (removal of radiator bottom tank or "rodding" out a radiator core), then that method can be used

Finally, dried silica-gel may be removed from a cooling system component by removing that component from the coach and agitating it in a caustic solution. Extreme care must be taken when handling such caustic solutions. Safety glasses and protective gloves should be worn. **Do not flush engine cooling system with caustic solutions because damage can occur to both metallic and non-metallic compoonents.**

The following recommendations are made to prevent silica-gel formation:

- Use antifreeze that meets GM-6038M formulation which limits the amount of silicate to 0.1% maximum.
- Use antifreeze solutions at the concentration required for freeze protection in your operational area, but **do not** use more than 67% antifreeze or less than 30% antifreeze.
- Never use 100% antifreeze for make-up coolant. Mix the make-up solution at the same concentration as the original fill.
- Use corrosion inhibitor supplements only as required to maintain proper system protection. The system should be tested to determine the need for additional inhibitor. Test kits and test strips are commercially available to check engine coolant for corrosion inhibitor strength level. Coolant should be tested to determine the need for corrosion inhibitor supplements and the amount required. Do not use one manufacturer's test to measure the inhibitor strength level of another manufacturer's product. Always follow the manufacturer's recommended test procedures. New additives Nalcool 3000 with stabil-aid and Fleetguard DCA4 have been developed to help prevent silicate dropout and this may be added to the system when need arises.
- As much as possible, avoid using what can be considered "hard" water when mixing with antifreeze.

A list of available antifreeze products that meet GM-6038M is shown below:

Company	Product
Texaco (1)	2055 (was JC-04)
BASF Wyandotte (1)	241-7
International Harvester (1)(5)	I.H. Antifreeze
Old World Trading Co. (1)	Full Force Advance
Northern Petro-Chemical (2)	All Weather (NPC 220)
Dow Chemical Canada(3)	731
Houston Chemical Corp. (4)	Security (701)

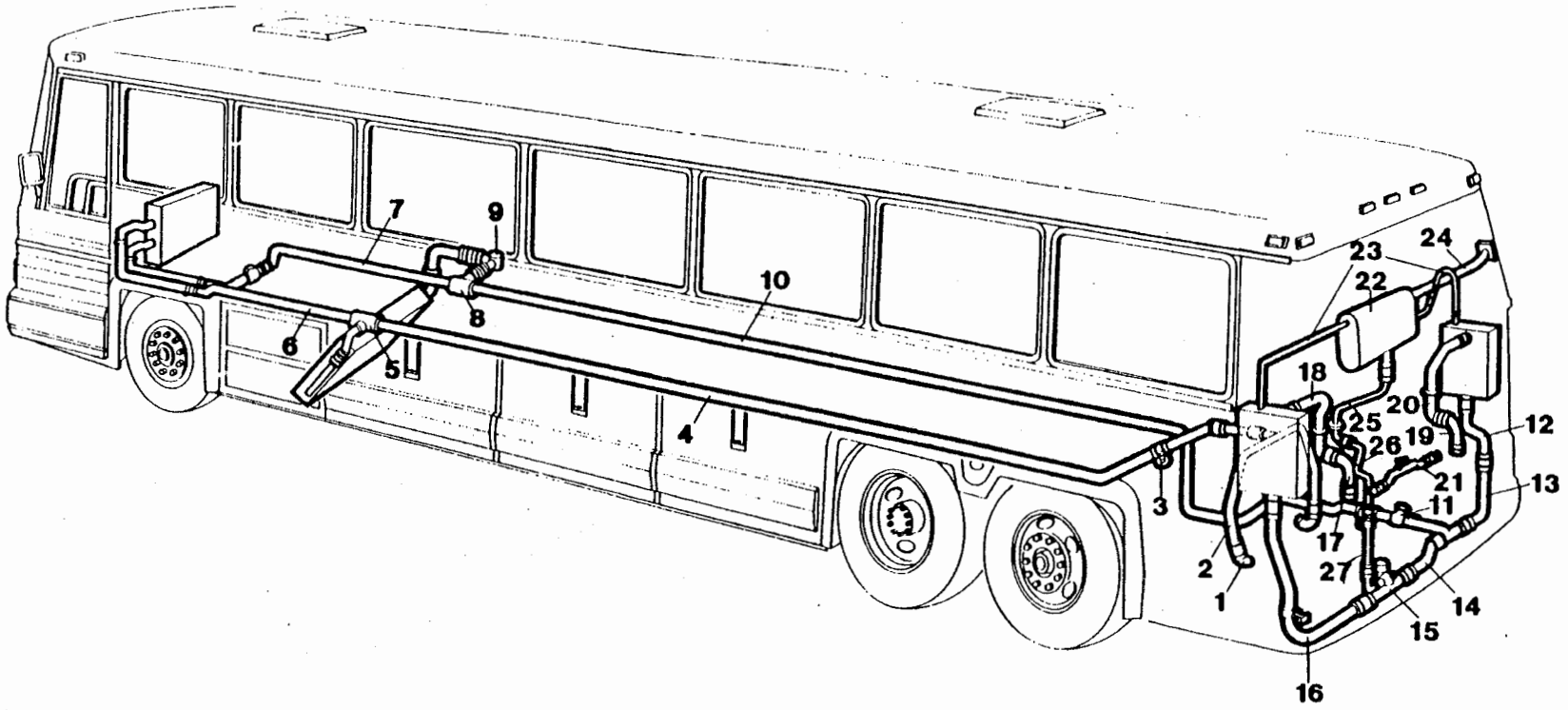
(1) Generally available in U.S.A.
(2) Generally available within 750-mile radius of Chicago
(3) Generally available in Canada.
(4) Generally available in northeastern U.S.A.
(5) I.H. antifreeze in Canada has high silicate content.

COOLANT FILTERS - GENERAL

Replaceable elements are available with various chemical inhibitor systems. Compatibility of the element with other ingredients of the coolant solution cannot always be taken for granted.

Problems have developed from the use of the magnesium lower support plate used by some manufacturers in their coolant filters. The magnesium plate will be attacked by solutions which will not be detrimental to other metals in the cooling system. The dissolved magnesium will be deposited in the hottest zones of the engine where heat transfer is most critical. The use of an aluminum or zinc support plate in preference to magnesium is recommended to eliminate the potential of this type of deposit.

High chloride coolants will have a detrimental effect on the water-softening capabilities of systems using ion-exchange resins. Accumulations of calcium and magnesium ions removed from the coolant and held captive by the zeolite resin can be released into the coolant by a regenerative process caused by high chloride-content solutions.



1. Supply Elbow
2. Crossover Manifold
3. Gate Valve
4. Supply Line
5. Supply Tee
6. Driver's Heater Supply Line
7. Driver's Heater Return Line
8. Return Tee
9. Main Heater Valve
10. Return Line
11. Gate Valve
12. Upper R.H. Radiator Outlet Tube
13. Lower R.H. Radiator Outlet Tube
14. Crossover Tube
15. Y-Connector Pump Inlet
16. L.H. Radiator Outlet Tube
17. Lower L.H. Radiator Inlet Tube
18. Upper L.H. Radiator Inlet Tube
19. Lower R.H. Radiator Inlet Tube
20. Upper R.H. Radiator Inlet Tube
21. By-Pass Tube - Between Thermostats
22. Surge Tank
23. L.H. & R.H. Recirculating Hose
24. Surge Tank Filler Tube
25. Upper Surge Tank Tube
26. Center Surge Tank Tube
27. Lower Surge Tank Tube

Figure 6-5. Coach Cooling System.

MC-9 MAINTENANCE MANUAL

DRAINING COOLING SYSTEM

The cooling system may be completely or partially drained by using the following procedures.

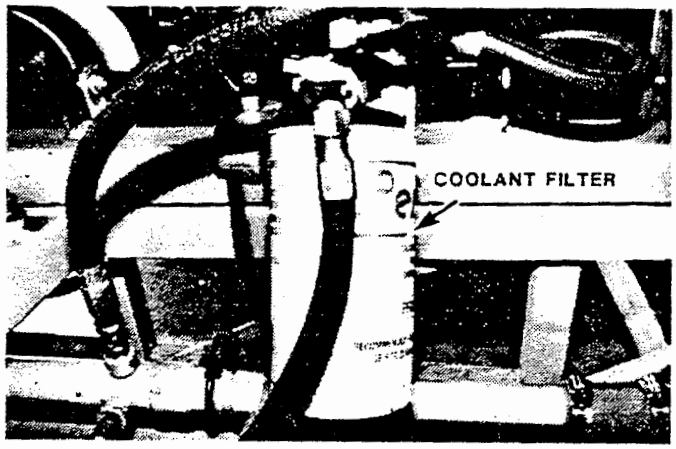
CAUTION: After draining the cooling system attach a suitable tag to the steering wheel indicating that the cooling system is dry.

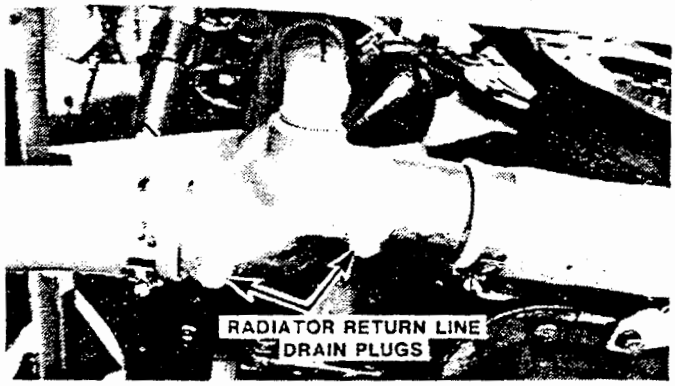
To drain the entire system leave the two gate valves open and proceed with the following: (See figures 6-5, 6-6 and 6-7.)

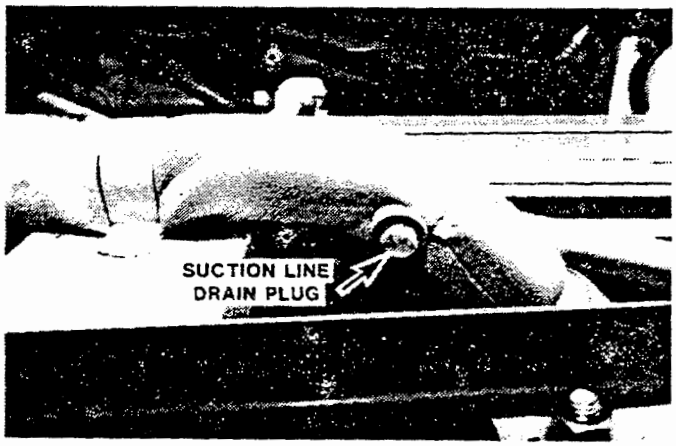
1. Depress the vent button at the radiator filler cap.
2. Open the filler cap.
3. Remove the drain plug at the radiator return line tee, located below the engine water pump.
4. When the coolant has drained, open the bleeder valve on the driver's heater core.
5. Remove the drain plugs from the suction line, the engine oil cooler, and the air compressor.

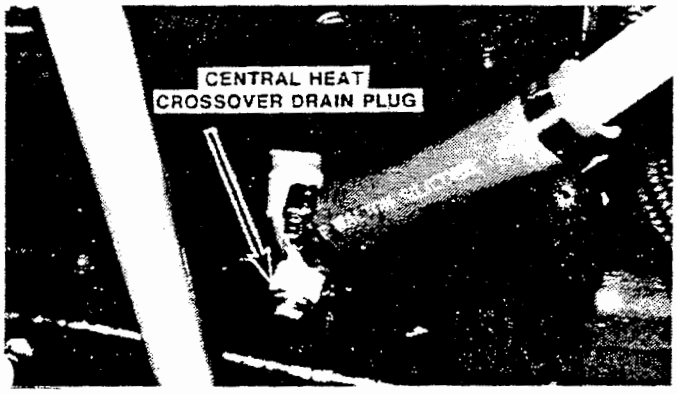
To drain only the engine and related components, close the two gate valves and proceed as follows:

1. Depress the vent button on the radiator filler cap.
2. Open the radiator filler cap to allow air into the system as the coolant drains.
3. Remove the drain plug at the radiator return line tee, located below the water pump.
4. Remove the drain plugs from the central heat crossover line, or on coaches equipped with a coolant filter, open the drain cock on the filter.
5. Remove the drain plugs from the suction line, the engine oil cooler, and the air compressor.









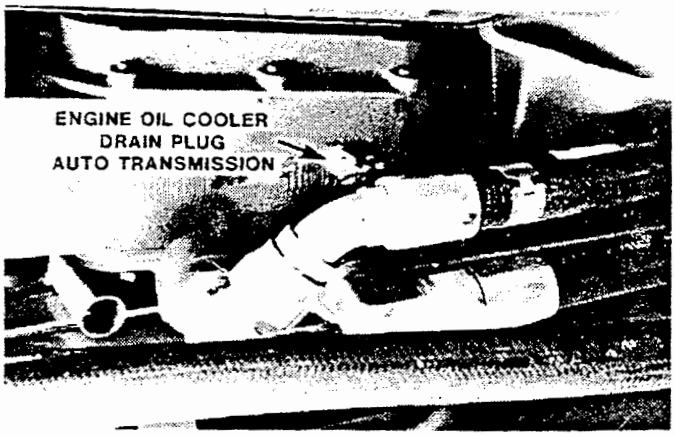


Figure 6-6. Drain Plugs and Coolant Filter.

MC-9 MAINTENANCE MANUAL

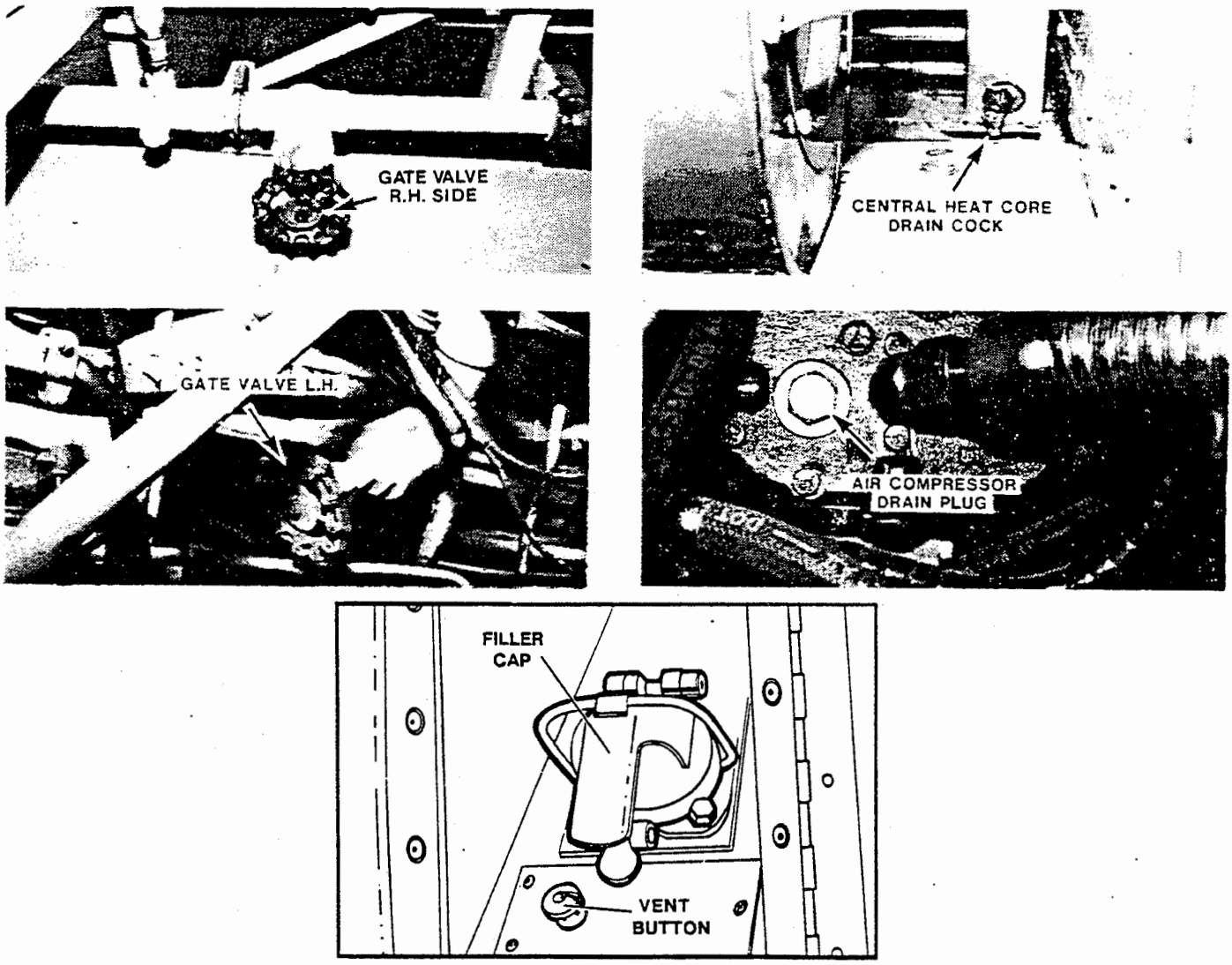


Figure 6-7. Cooling System Drains and Valves.

REFILLING COOLING SYSTEM

To fill the system, close all drain plugs and cocks, open the gate valves and fill the system halfway with a 50-50 mixture of water and ethylene glycol antifreeze. Start the engine and fill the system completely. The cooling system is completely filled when coolant shows approximately halfway up in the surge tank sight glass. See figure 6-8.

When the cooling system is filled to capacity with cold coolant solution, expansion of the coolant takes place as it heats up. During this initial warm-up period it is possible to lose as much as a gallon and a half of coolant. No further coolant loss should be experienced after this period.

CAUTION: Never pour cold coolant into a hot engine. The sudden change in temperature may crack the cylinder head or block.

COOLANT FILTER

A spin-on coolant filter is available as optional equipment. The filter can be reached through the right hand side engine compartment service door

The element should be replaced every 500 hours, or 20,000 miles (32,000 km). MCI/TMC recommend the use of Perry Filter PFC-22B (MCI/TMC P.N. 6F-8-131) replacement element.

To remove the filter element, close the two shut-off cocks at the filter mounting head and remove the old element.

Clean the area around the mounting head and install the

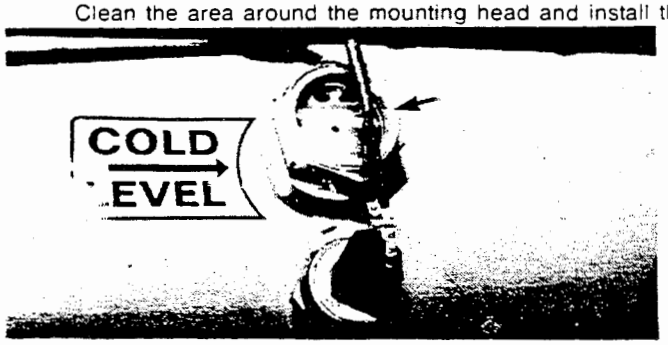


Figure 6-8. Surge Tank Sight Gauge.

replacement element. Be sure to follow the manufacturer's instructions when installing a new element.

Open the two shut-off cocks at the filter.

For the location of main cooling system components, refer to figure 6-9.

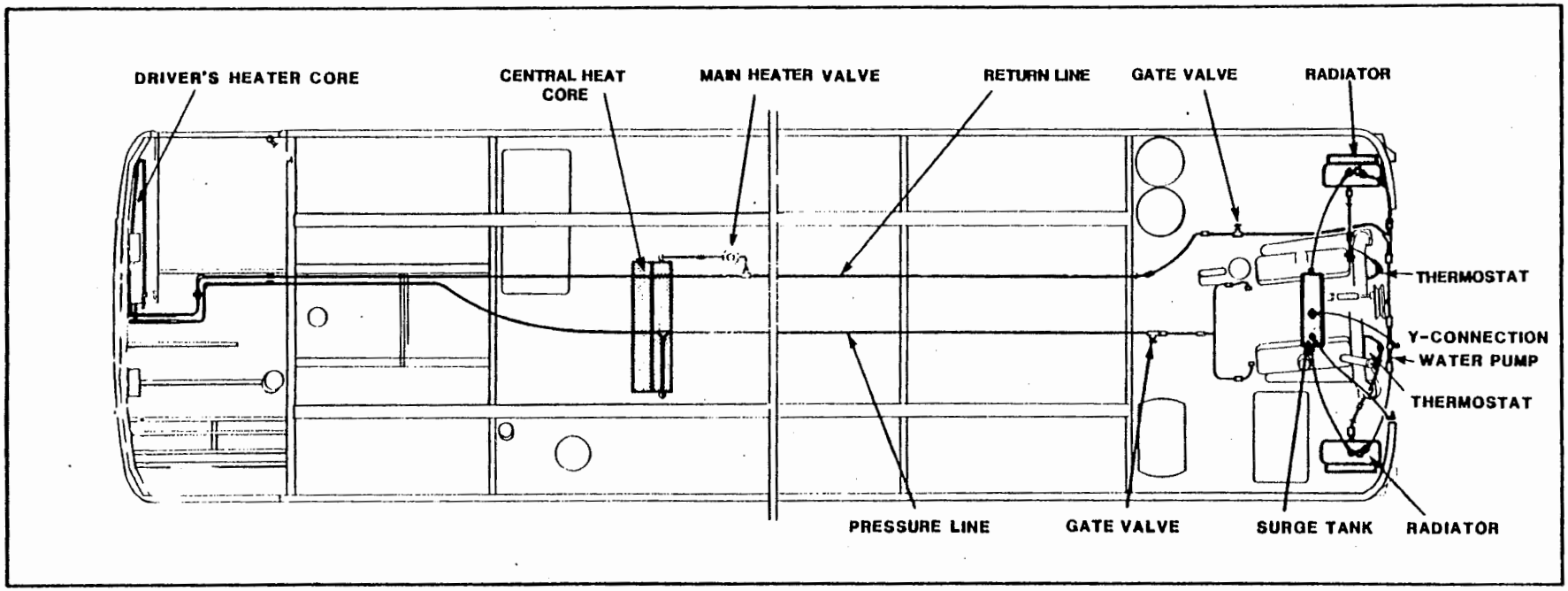


Figure 6-9. Cooling System Component Locations.

MC-9 MAINTENANCE MANUAL

COOLANT RECOVERY SYSTEM (OPTION)

The automatic coolant recovery system limits the loss of overflow coolant. This is accomplished by a coolant recovery tank with a capacity of six U.S. gallons (22.7 liters). The system also includes a coolant pump with electrical controls (figure 6-10), a tell-tale light on the dash, and a tell-tale light and test switch on the remote control box in the engine compartment. Low coolant sensors in the surge tank are also used, in conjunction with the automatic pump controls.

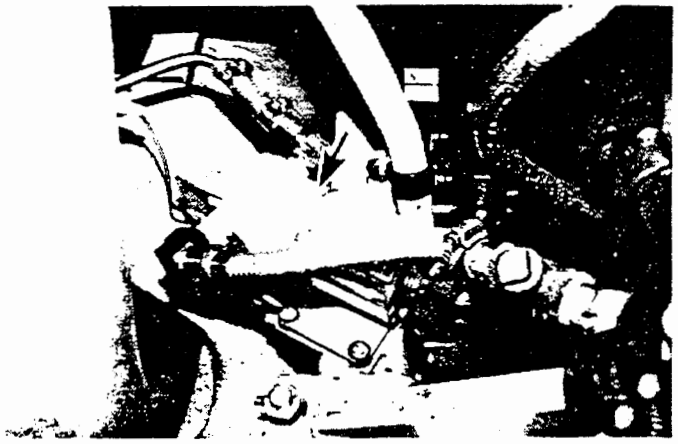


Figure 6-10. Coolant Recovery System Pump.

OPERATION

When the battery switch is ON and the coolant in the surge tank falls below a certain level, the coolant sensors activate the pump and tell-tale lights. When activated, the pump automatically fills the cooling system from the recovery tank, and shuts off when the system is full. The pump will not operate when the recovery tank is empty.

Filling the cooling system is accomplished through the recovery tank. See figure 6-11. This eliminates the danger of hot, pressurized coolant as the recovery tank is not pressurized. Procedures for draining and filling the cooling system are detailed earlier in this section.



Figure 6-11. Coolant Fill Cap.

MAINTENANCE

At regular service intervals the operation of the tell-tale lights and pump should be checked.

Push the Fill Bulb Test switch on the remote control box to the BULB TEST position and ensure that both tell-tale lights illuminate.

To check the pump, push the switch to the FILL position and ensure that the pump operates.

During normal coach operation, if the tell-tale lights are on and the pump is not running, the coolant level in the recovery tank is low and should be replenished.

DRAINING

To drain only the engine and related components close the two gate valves and proceed as follows:

1. Turn the battery switch ON.
2. Remove the drain plugs at the radiator return line tee, located below the engine water pump.
3. As the coolant drains below the sensor in the surge tank, the LOW WATER tell-tale on the remote control box will come on and the pump will start. When the recovery tank is drained, the pump will shut off.
4. Turn the battery switch OFF.
5. Remove the drain plug from the central heat crossover line, or on coaches equipped with a coolant filter, open the drain cock at the filter.
6. Remove the drain plugs from the suction line, the engine oil cooler, and the air compressor.

NOTE: Descriptions and locations of cooling system drain points were outlined previously in this section. See figures 6-6 and 6-7.

To drain the entire cooling system the gate valves should be left open and the bleeder valve on the driver's heater core should be opened after the coolant has drained.

CAUTION: After draining the cooling system attach a suitable tag to the steering wheel indicating that the cooling system is dry.

REFILLING

On coaches equipped with the coolant recovery system, the cooling system filler tube is located below the remote control panel in the engine compartment. See figure 6-11.

To fill the system, close all drain cocks and plugs, ensure that the gate valves are open, if filling the entire system, and proceed as follows:

1. Turn the battery switch ON. The LOW WATER tell-tale light on the remote control box will come on. If it does not work, check the light using the Fill Bulb Test switch.
2. Add five gallons (18.9 liters) of coolant to the recovery tank. The pump will begin to operate, pumping coolant into the system.
3. Open the petcock on the water bypass tube between the engine thermostats. This will allow air to bleed as the system fills. When coolant begins to flow, close the petcock.
4. When the recovery tank has drained, the pump will shut off

5. Continue adding coolant to the recovery tank, five gallons (18.9 liters) at a time, until the pump and tell-tale light shut off. At this point the cooling system is full.

6. Fill the recovery tank until coolant is four to six inches (102-153 mm) from the top of the filler tube. This space will allow the coolant to expand as it warms up, without overflowing.

CAUTION: Never pour cold coolant into a hot engine. The sudden change in temperature may crack the cylinder head or block.

WATER PUMP SEAL

Engines built prior to January 1987 have water pump seals made of a material which tends to harden at high temperatures. As of that date, Detroit Diesel changed the seal to one made of a material which performs better at high temperatures.

The water pump seal should be replaced after it has been in service for 200,000 miles or 6,000 hours.

ALARMSTATS

Two alarmstats activate the warning light and buzzer that indicate engine overheating. See figure 6-12. Further information on the alarmstats can be found in Section 7 of this manual.

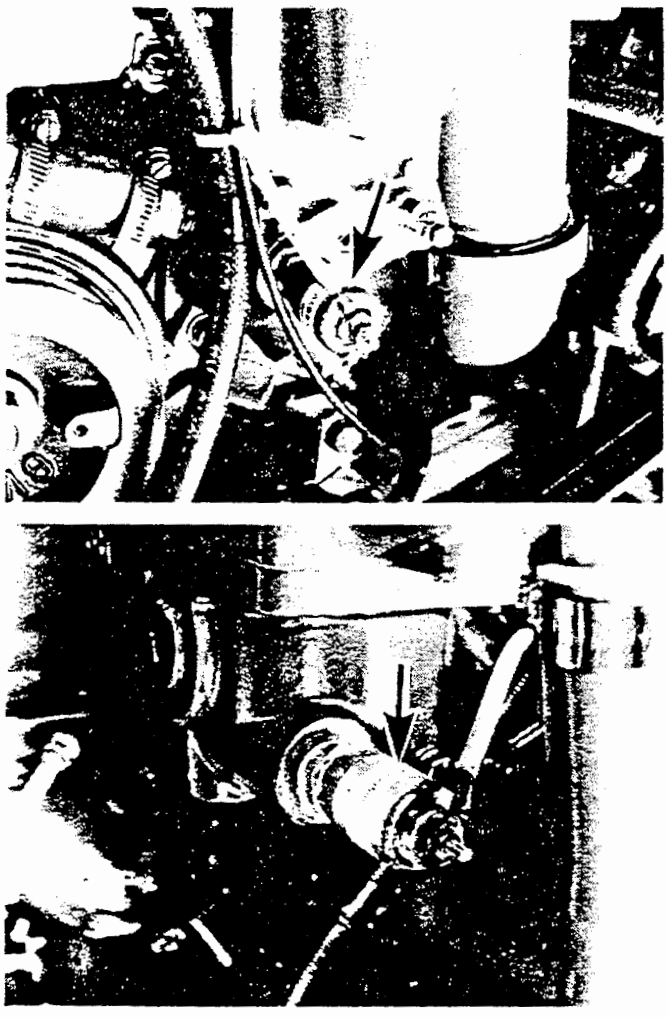


Figure 6-12. Left and Right Side Alarmstats.

RADIATORS

Twin radiators are mounted at the rear corners of the coach (in engine compartment) at a height which minimizes the intake of dust and road dirt.

The radiators are designed to reduce the temperature of the coolant under all operating conditions. It is essential that the radiator cores be kept free from corrosion and debris at all times in conjunction with the regular maintenance of the other components of the cooling system.

Radiators with larger capacity are installed on those coaches with 8V-92TA engines. Refer to specifications at the end of this section for the capacities of the cooling system with standard or larger radiators, or with the coolant recovery system.

RADIATOR SHUTTERS AND SHUTTERSTATS

An air-operated shutter assembly is provided on the intake side of each radiator core. Each shutter assembly is controlled by a separate air cylinder. See figure 6-13. The air supply to the cylinders is controlled by the shutterstat, which is mounted on the right-hand radiator inlet line.

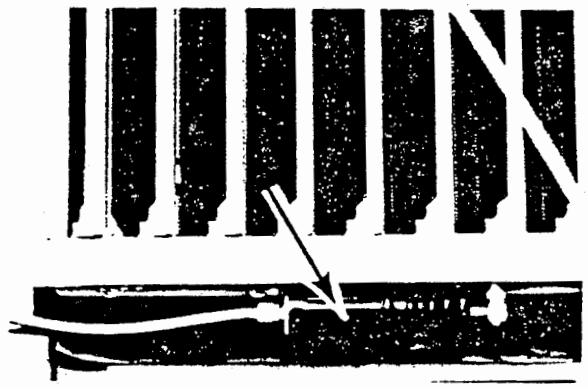


Figure 6-13. Shutter Air Cylinder.

The shutterstat controls the supply of compressed air to the radiator shutter air cylinders. It is mounted on the right-hand radiator inlet line and can be reached for service by opening the rear engine compartment service doors. Refer to figure 6-14.

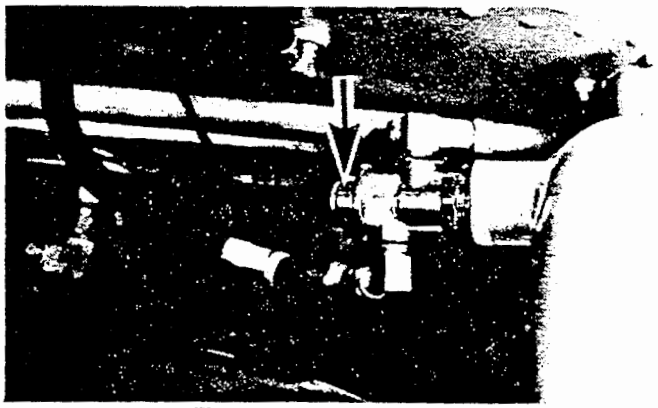


Figure 6-14. Shutterstat.

When the engine coolant reaches the temperature of the shutterstat setting, the shutterstat cuts off the air supply to the radiator shutter air cylinder, and the shutters open. When the coolant temperature is below the setting of the shutterstat, air is allowed to enter the radiator shutter air cylinders, closing the shutters.

The only maintenance required for the shutterstat is to ensure that the air exhaust holes are kept free of dirt.

SHUTTERSTAT REMOVAL

Before removing the shutterstat, it is necessary to drain the engine coolant. Refer to Draining Cooling System outlined previously in this section.

1. When the coolant has drained, disconnect the shutterstat air lines and plug or tape them to prevent contamination.
2. Unscrew and remove the shutterstat.
3. The shutterstat is non-serviceable; if it is found to be defective, it should be discarded and replaced.

After replacing the shutterstat, connect the air lines and refill the cooling system. Refer to Refilling Cooling System, outlined previously in this section.

SHUTTERSTAT AIR FILTER

The shutterstat air filter is mounted on the inside vertical wall of the righthand radiator compartment floor pan (figure 6-15). The filter prevents moisture from entering the air operated components of the blower and shutter air system.

As air enters the filter it strikes the baffle, which diverts any moisture in the air stream to the bottom of the filter housing. The air then passes through two felt filtering elements before flowing to the shutterstat, blower belt adjusting air cylinder.

A periodic check should be made to ensure that there are no air leaks at the filter connections.

The air filter fluid chamber holds approximately one ounce (28 ml) of fluid. Part of the weekly maintenance procedure

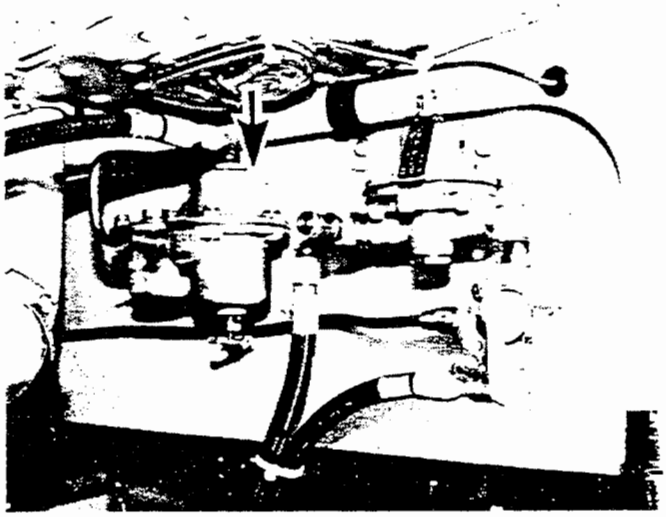


Figure 6-15. Shutterstat Air Filter.

should be to drain the filter by opening the draincock at the bottom of the filter body while the filter is under pressure. During cold weather operation, the filter should be drained daily.

At intervals of 3,000 miles (4,800 km) one ounce (28 ml) of Kysor Air Filter Fluid (P.N. 6-10-33) should be added to the filter. Remove the plug on the top of the filter body, add fluid and replace the plug.

At intervals of 10,000 miles (16,000 km) the air filter should be disassembled and the felts cleaned with commercial solvent or replaced. See figure 6-16. When reassembling the filter, use a new gasket.

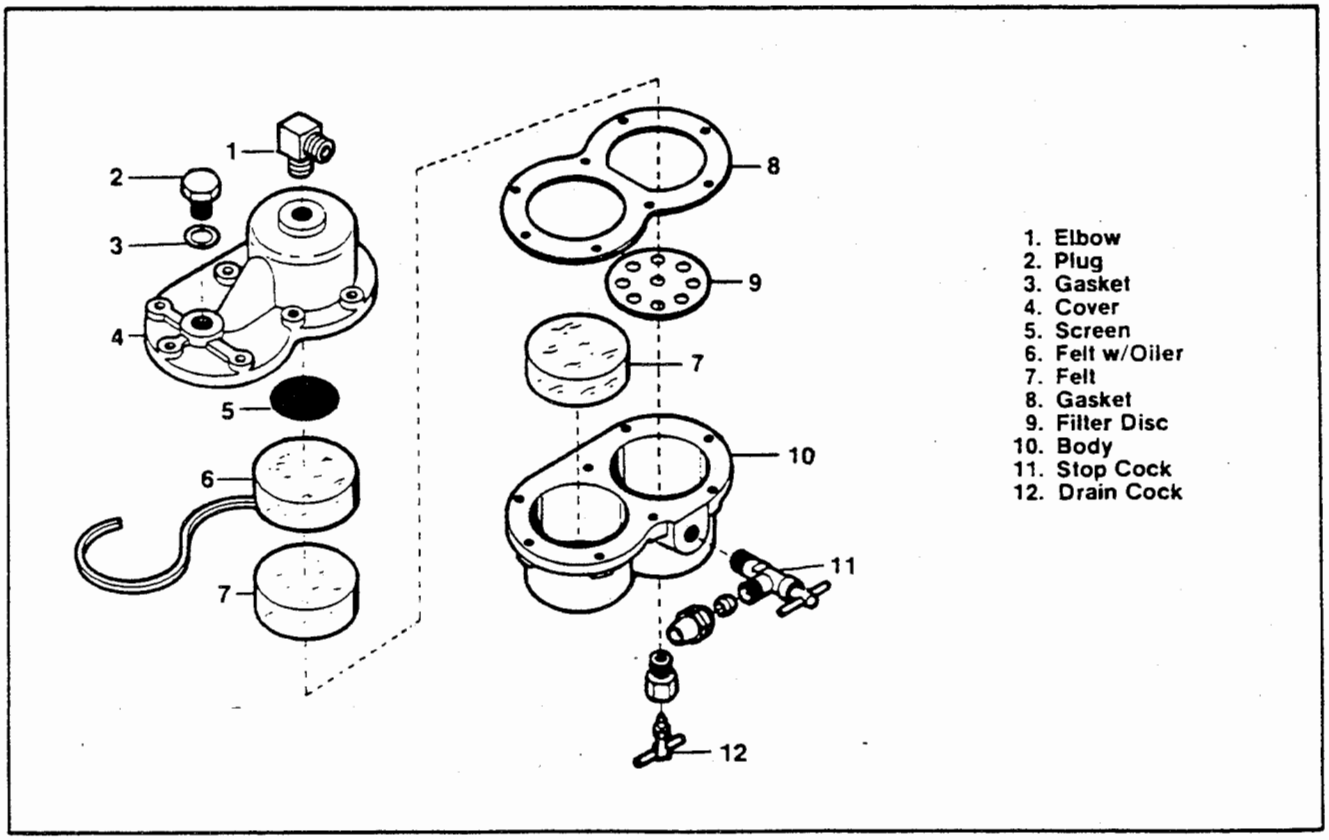


Figure 6-16. Shutterstat Air Filter Parts Breakdown.

MC-9 MAINTENANCE MANUAL

BLOWER GEAR BOX

The engine cooling blowers are located in a separate compartment above the engine. The blower wheels are mounted on a bevel gear box which is driven by means of a V-belt from the engine crankshaft. See figure 6-17. Outside air is drawn in through the radiators and discharged by the blower into the engine compartment.

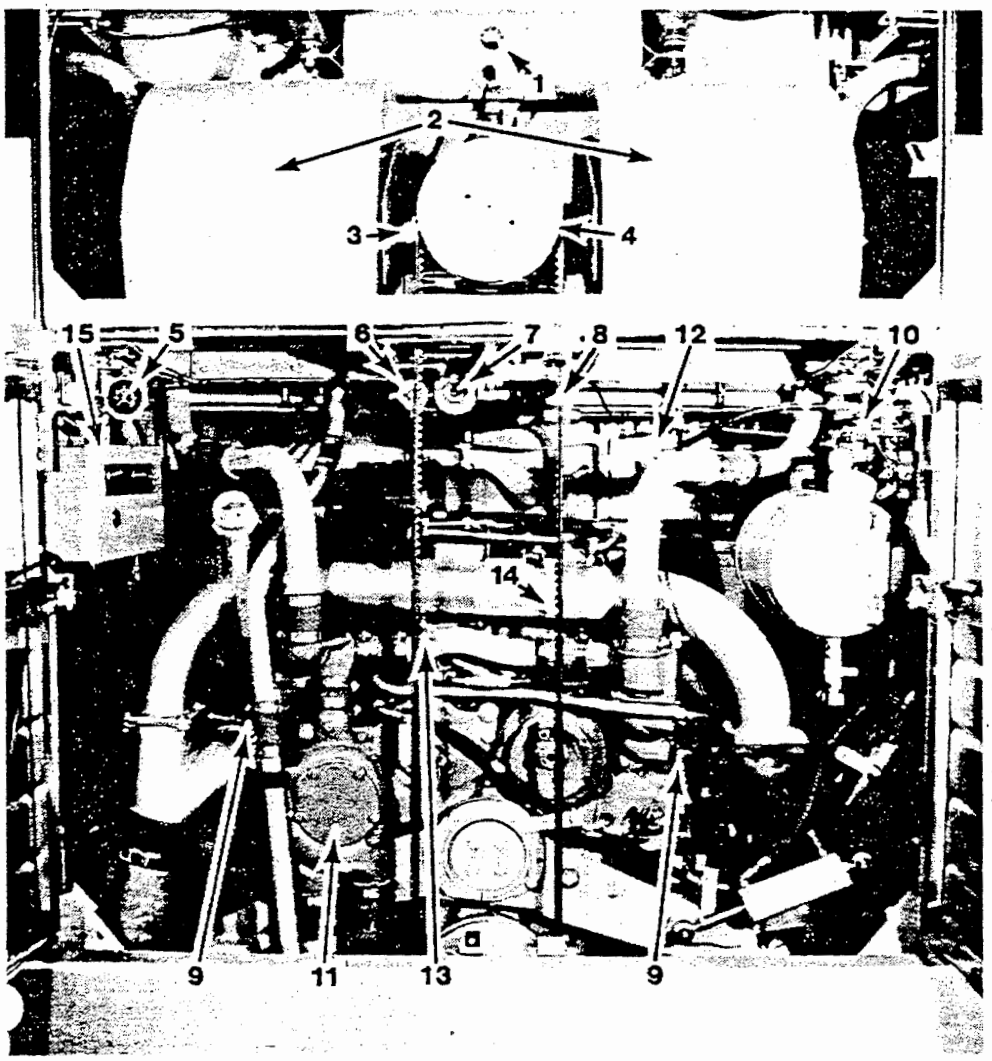
Maintenance for the blower gear box is minimal; it contains its own oil supply, and part of the daily maintenance procedures should be to inspect the oil level. The correct level is when oil is visible to the halfway point in the sight gauge. Add oil as required in accordance with Section 10 (Lubrication) of this manual.

Make a periodic check of the sealed areas of the gear box to ensure that there is no oil leakage. If any leakage is detected, replace the defective seals or gaskets.

The blower wheels should be checked to ensure that they are tight on the shafts. If necessary tighten the retaining nut until at least one shaft thread is visible through the nut.

The blower wheels are dynamically balanced and care should be taken to prevent the blades from being bent. Any accumulations of grease or dirt, which may cause the wheels to become unbalanced, should be removed.

CAUTION: Never leave loose objects such as towels or rags in the blower compartment as they may be sucked into the blower wheels causing excessive vibration and ultimate failure.



1. Surge Tank Sight Glass
2. Blower Housings
3. Blower Gear Box Sight Glass
4. Blower Gear Box Pulley
5. Temperature Gauge
6. 2-Way Air Control Valve
7. Blower Belt Cylinder Pressure Regulating Valve
8. Blower Belt Adjusting Air Cylinder
9. Alarmstats
10. Shutterstat Air Filter
11. Engine Water Pump
12. Shutterstat
13. Coolant Bypass Petcock Between Thermostats
14. Blower Gear Box Drive Belt
15. Remote Control Box

Figure 6-17. Cooling System Components in Engine Compartment.

MC-9 MAINTENANCE MANUAL

REMOVAL

The blower gear box and blowers may be removed through the blower compartment door. Remove the drive belt, as outlined under Blower Belt Air Cylinder - Removal, and proceed as follows:

1. Remove the capscrews that secure the blower housings to the blower compartment floor.
2. Remove the capscrews that secure the blower gear box to the blower saddle.

NOTE: Two shims are used to align the gear box. When removing the gear box and blower housings, take care not to lose the shims.

3. Remove the gear box and blower housing assembly.

INSTALLATION OF BLOWER GEAR BOX RUBBER MOUNTS

To properly insert the blower gear box rubber mounts into the blower saddle, only water should be used as a lubricant. Insertion of the rubber mounts using glycerine, or any other lubricant, will result in the tail of the mounts flaring out causing the rubber to rupture.

Using water as a lubricant will allow the tail of the mount to go into compression when the assembly is drawn up tight, giving the proper displacement bulge around the entire rubber mount.

In no case should a lubricant be used which maintains lubricity after assembly and engine start-up.

DISASSEMBLY

1. Remove four screws holding down top cover and remove cover and gasket.
2. Remove screws and output shaft covers.
3. Remove the capscrews that fasten the bearing carrier to the housing. The bearing carriers, input shaft, bearings and gears will then come out as a unit.

To disassemble input shaft assembly, remove retaining ring from the inner end at the bevel gear. Pull the gear from the shaft. The bearings and spacer can now be removed from the shaft. Using a soft mallet, tap the output shaft out of the housing. The tapered roller bearings and bevel gear will come out with the shaft. Pull or tap off the bearing cones, slide off the spacers and pull or press off the bevel gear.

Reassembly is the reverse of disassembly. When cover gasket is not available, seal the cover and body with Permatex Silicone Sealant.

REPAIR AND ASSEMBLY

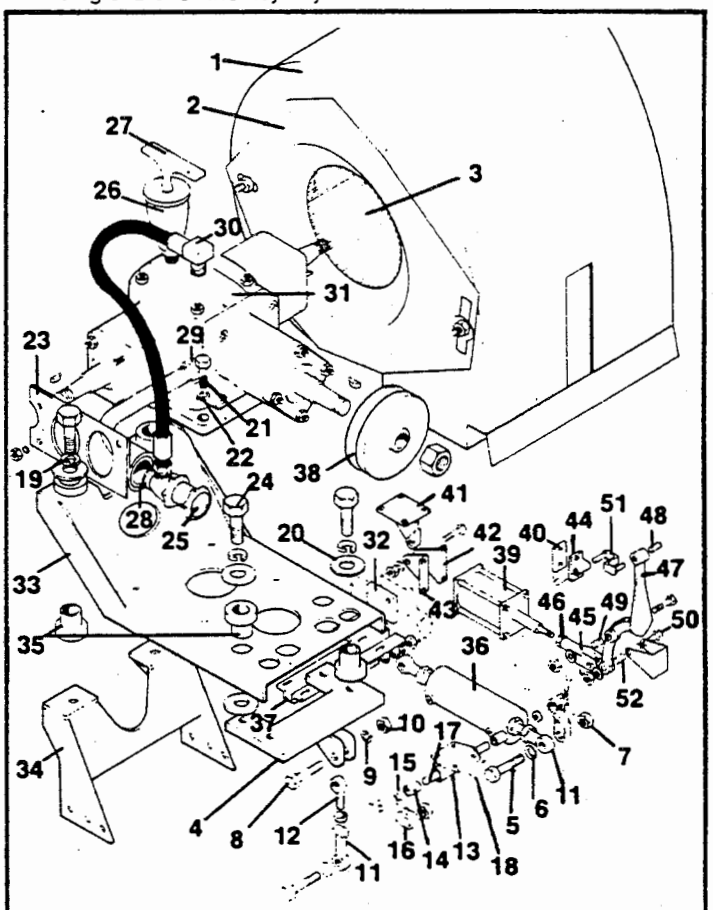
The gears are only supplied in matched, honed sets and must be installed so that the timing marks on the back of the gears are aligned properly.

The back edges of the miter gears must be flush when installed. This can be accomplished by using the proper number of brass shim gaskets under the output shaft bearing caps. Refer to figures 6-19 and 6-20.

The tapered roller bearings must be adjusted by means of brass shim washers so that there is no perceptible play or clearance in them.

Backlash of the spiral bevel gears is also controlled by the use of brass shims between the bearing carrier and the main housing; .003 to .004" (.076 - .101 mm) clearance + .002" (.050 mm) is recommended between gear teeth.

Care must be exercised when installing the shaft seals over the sharp keyways in the shafts. To avoid nicking the inner sealing lip, a thin tapered bushing should be made up to facilitate entry of the shaft in the seal and protect the seal while it is being slid over the keyways.



1. Housing
2. Inlet Ring
3. Blower Wheel
4. Adjusting Plate
5. Capscrew
6. Flat Washer
7. Lock Nut
8. Capscrew
9. Lock Washer
10. Nut
11. Uniball End - Female
12. Uniball End - Male
13. Tube & Bracket Assy.
14. Bushing
15. Seal
16. Lever
17. Shaft
18. Grease Fitting
19. Lock Washer
20. Washer
21. Capscrew
22. Lock Washer
23. Mounting Plate
24. Sight Gauge Tee
25. Sight Gauge
26. Oil Filler Cup
27. Cap Assembly
28. Clamp
29. Male Connector
30. Male Elbow
31. Blower Gear Box Assy.
32. Block
33. Saddle
34. Bracket
35. Rubber Mount
36. Air Cylinder
37. Bracket
38. Pulley
*39. Damper Air Cylinder Assy.
*40. Tapping Plate
*41. Mounting Bracket S/A
*42. Bracket - Trunnion (½" Dia. Hole)
*43. Bracket - Trunnion (⅜" Dia. Hole)
*44. Pillow
*45. Clevis
*46. Jam Nut
*47. Lever Assy.
*48. Bearing
*49. Bearing
*50. Shoulder Bolt
*51. "Z"-Link
*52. Bearing

*With Optional Blower Dampers

Figure 6-19. Blower Gear Box and Air Cylinder Linkage.

MC-9 MAINTENANCE MANUAL

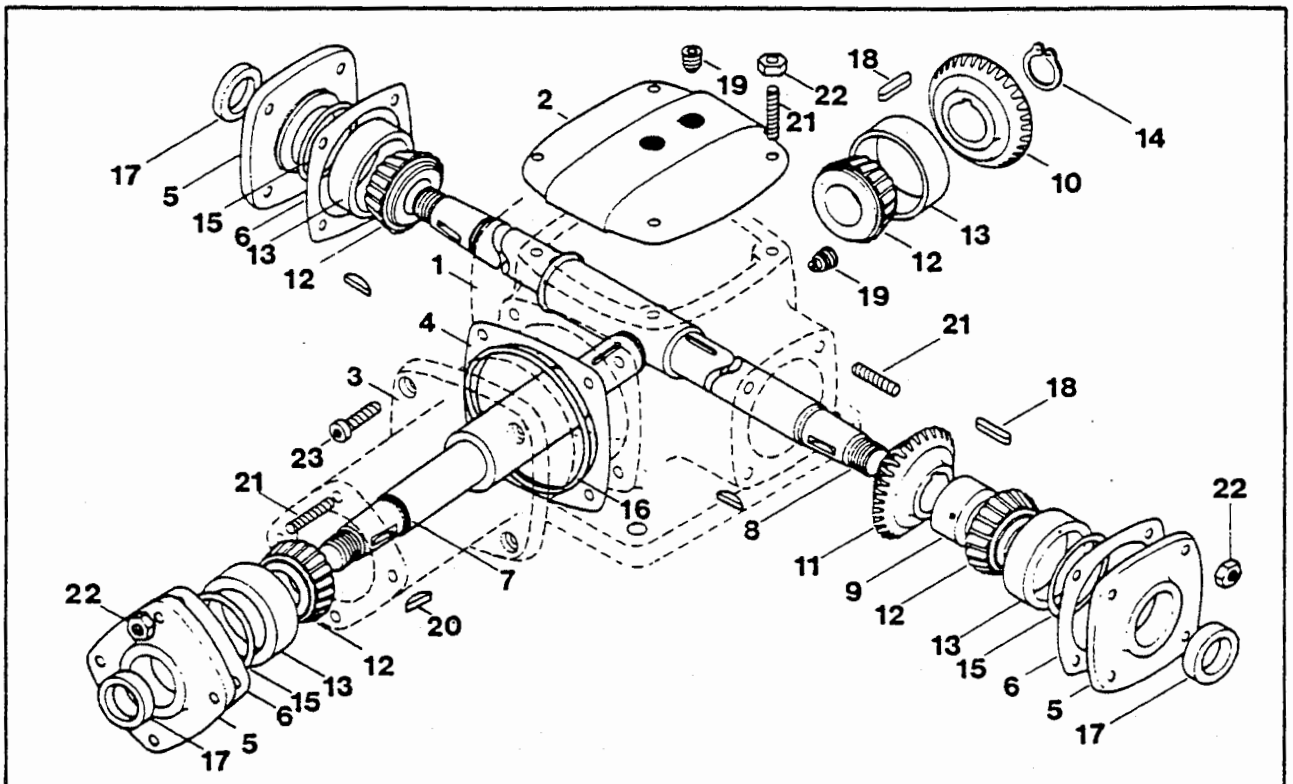


Figure 6-20. Blower Gear Box Component Parts.

BLOWER BELT AIR CYLINDER

An air operated blower belt adjusting cylinder is installed to ensure the correct tension on the blower gear box drive belt. Access to the air cylinder can be gained through the rear engine compartment service doors. See figure 6-21.

ADJUSTMENT

To maintain the correct tension on the blower belt, the air cylinder must be properly adjusted. With the air system under normal pressure and the pressure regulating valve set at 21 psi (144.8 kPa), the shaft length must be 1¼" ± ⅛" (31.7 mm ± 3.1 mm), as shown in figure 6-21

If the shaft is not within these tolerances, adjust the cylinder as follows:

1 Loosen the jam nut on the shaft end of the cylinder.
2 Rotate the shaft to attain the specified length.
3. Tighten the jam nut.

NEW BELTS

When a new blower drive belt is installed, it may be difficult to attain the specified shaft length on the air cylinder. The drive belt stretches with normal wear, and after approximately 500 miles (800 km) the shaft length should return to 1¼" ± ⅛" (31.7 mm ± 3.1 mm).

At the end of this run-in period the shaft length should be checked and, if necessary, adjusted.

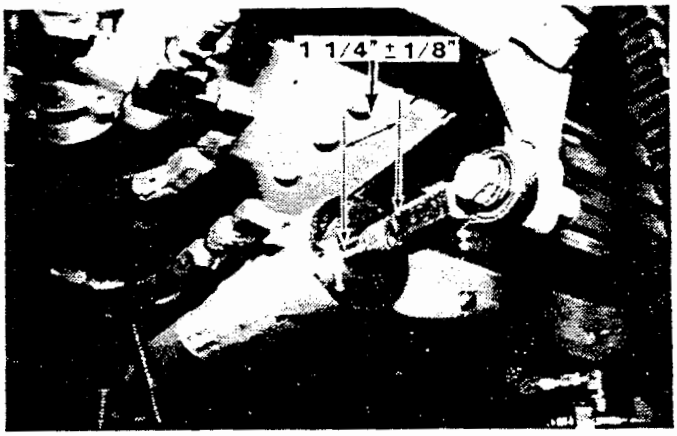


Figure 6-21. Belt Air Cylinder Adjustment.

MC-9 MAINTENANCE MANUAL

MAINTENANCE

It is recommended that the blower belt tension air cylinder be lubricated at regular intervals, approximately every 30,000 miles (48,000 km).

The recommended procedure is as follows:

Remove air feed hose from cylinder and apply a few drops of SAE 30 or 40 engine oil into cylinder hose connector. Reconnect the hose, then reverse the air supply to the cylinder; this will lubricate the other end of the cylinder. Check cylinder for air leaks.

When overhauling cylinder, it is very important to replace all seals, felts, cups and O-rings with new parts for proper operation.

NOTE: When overhauling cylinder new parts should be coated with oil before assembly.

REMOVAL

1. Shut off the air supply to the cylinder by turning the two-way control valve handle (figure 6-22). This will compress the cylinder spring and release the tension on the blower drive belt

2. Remove the blower drive belt.

3. Remove the capscrew and lock nut that connects the air cylinder rod end to the cross shaft assembly.

NOTE: When removing the capscrew from the rod end, it may be necessary to adjust the two-way control valve in order to relieve the pressure on the capscrew.

4. Close the shut-off cock on the shutterstat air filter. This will prevent excessive loss of air when the cylinder is removed.

5. Disconnect the two hoses from the air cylinder.

6. Remove the capscrew and nut from the far end of the cylinder and remove the cylinder from the coach.

WARNING: Do not attempt to disassemble the air cylinder while it is in the coach.

DISASSEMBLY

1. Remove the two rods ends and studs from the cylinder. See figure 6-23.

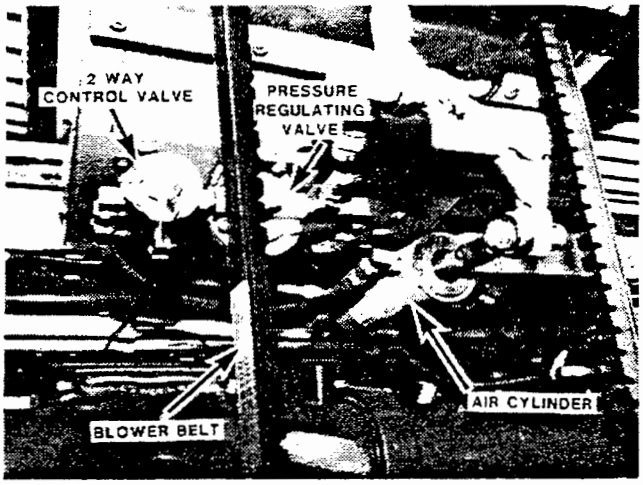


Figure 6-22. Blower Belt Air Cylinder.

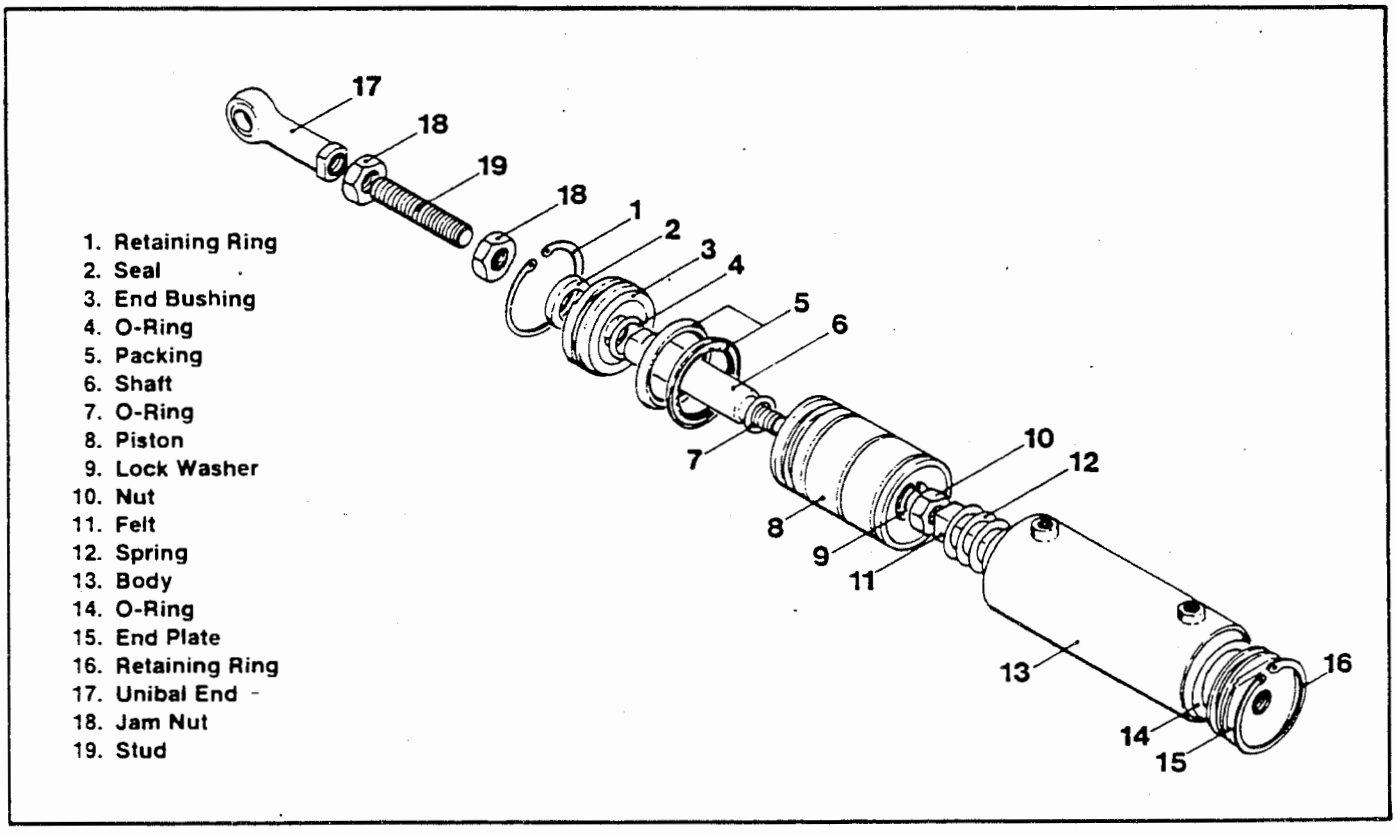


Figure 6-23. Blower Belt Air Cylinder Parts Diagram.

2. Place the cylinder on the bed of an arbor press, with the piston rod up.

3. Slowly bring the ram of the arbor press down on the piston rod. Depress the piston rod approximately ½" (12.7 mm) to relieve the spring pressure on the cylinder end plate.

NOTE: Before continuing, lock the arbor press in position or have an assistant maintain the arbor pressure on the piston rod.

4. Release the retaining ring from the cylinder groove using a pair of retaining ring pliers and, if necessasry, a small screwdriver.

WARNING: The air cylinder end plate is under 50-60 lbs. (22.6-27.2 kg) of internal spring pressure. To avoid personal injury, exercise extreme caution during the disassembly of the cylinder.

5 Slowly release the arbor pressure from the piston rod. This will allow the removal of the cylinder end plate from the cylinder.

6. Once the end plate has been removed, the other internal components of the cylinder may be removed for cleaning and inspection.

INSPECTION

1 Inspect all O-rings, packings, felts and seals.

2 Inspect the cylinder bore and piston for scoring.

3. Inspect the retaining rings and ensure that they are not bent or otherwise damaged. Replace any parts that are damaged.

4 Check the spring tension to ensure that it is within the tolerances listed under Specifications at the end of this section. If the spring does not meet the specifications, it should be replaced.

REASSEMBLY

Coat all new parts with SAE 30 or 40 engine oil prior to assembly Reassemble the internal components in the reverse order of disassembly, and proceed as follows:

1. Place the cylinder on the bed of the arbor press with the piston rod up.

2. Slowly bring the ram of the arbor press down on the piston rod.

WARNING: Before applying any force on the piston rod, ensure that the cylinder is firmly positioned on the press. Failure to do so may allow the cylinder to slip from the press.

3. Depress the piston rod until the end plate is approximately 1/16" (1.5 mm) beyond the retaining ring groove. Take care not to damage the oil seal.

NOTE: Before continuing, lock the arbor press in position or have an assistant maintain the pressure on the piston rod.

4. Install the retaining ring in the groove. Ensure that it is completely in the groove before removing the cylinder from the press.

INSTALLATION

1. Install the studs, jam nuts, and rod ends onto the ends of the cylinder.

2. Using the capscrew and nut, connect the rod end, opposite the piston rod, to the lower gear box adjusting bracket.

3. Connect the hoses to the air cylinder

4. Using the capscrew and nut, connect the rod end, on the piston rod end of the cylinder, to the cross shaft assembly.

NOTE: When inserting the capscrew through the rod end, it may be necessary to adjust the two-way control valve to provide the necessary freeplay for installation.

5. Install the blower drive belt.

6. Turn the two-way control valve ON.

MC-9 MAINTENANCE MANUAL

BLOWER DAMPERS - OPTIONAL

Each blower assembly is provided with an air-operated damper which operates in conjunction with the radiator shutters to prevent the flow of air during engine warm-up. The dampers are located in the outlet ducts of the blowers.

Blower damper linkage adjustment should not be necessary unless the original adjustment is disturbed in disassembly. If an adjustment is to be made, the following method should be followed:

1. Disconnect the air cylinder at damper control lever by removing the clevis pin.
2. Operate the air cylinder so that the ram is fully extended.
3. Hold the damper in the fully closed position, then adjust the clevis until clevis pin holes line up with clevis pin hole in the damper lever.
4. Reconnect the air cylinder to the damper control lever by inserting the clevis pin.
5. Operate the dampers several times to check opening and closing. If dampers are not closing properly, remove clevis pin and unscrew clevis ½ turn, reinstall clevis pin and check closing again; repeat as necessary ½ turn per time until dampers are closing with a slight pressure.

Worn linkage parts or air cylinders should be replaced.

Lubricate at pivot points at regular chassis intervals with a rust-preventive oil.

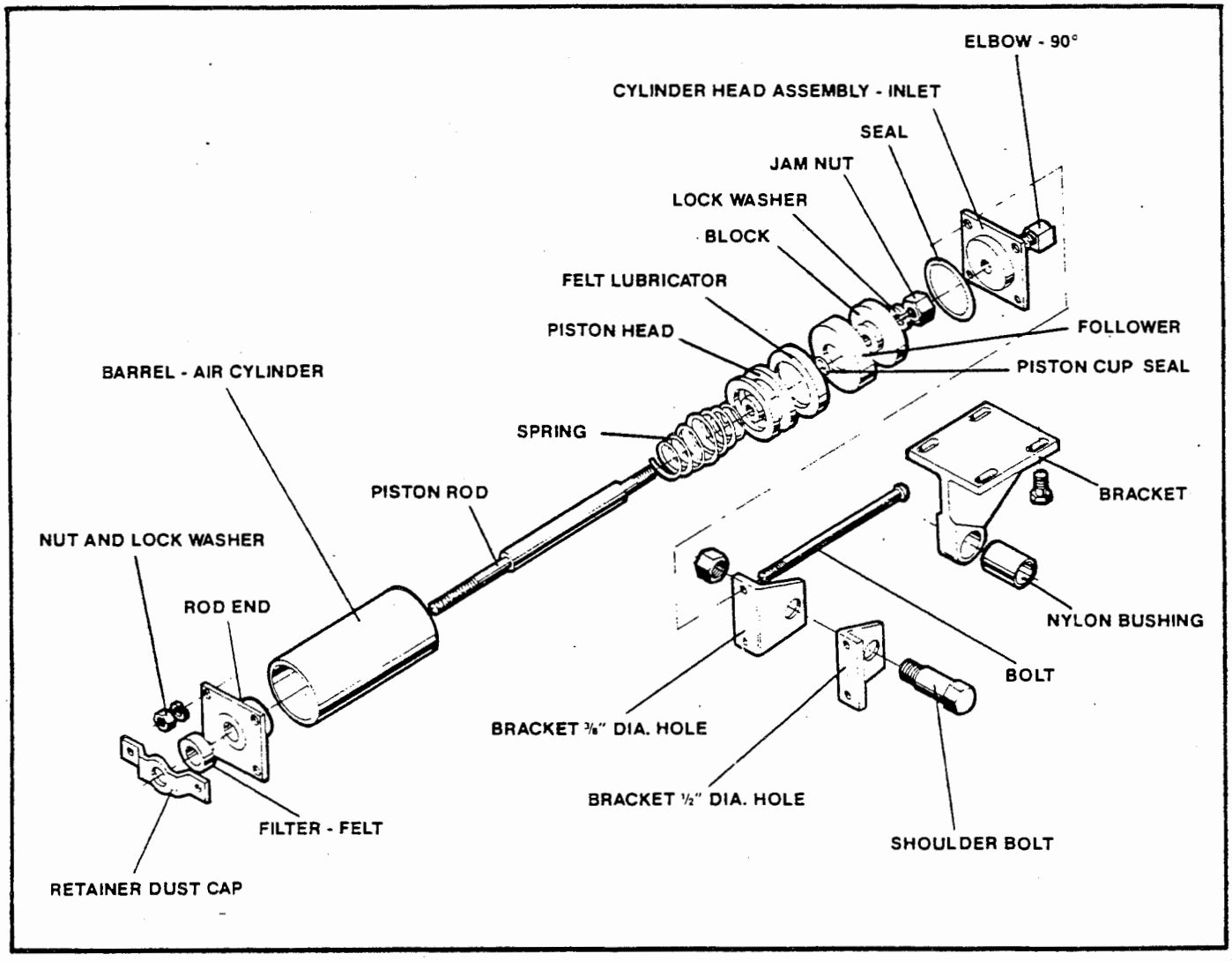


Figure 6-24. Blower Damper Air Cylinder.

MC-9 MAINTENANCE MANUAL

SPECIFICATIONS

COOLING SYSTEM CAPACITY WITH:

Standard Radiators	23 U.S. Gallons (87.0 liters)
Larger Radiators	24 U.S. Gallons (92.7 liters)
Cooland Recovery System and Standard Radiators	29 U.S. Gallons (109.7 liters)
Coolant Recovery System and Larger Radiators	30 U.S. Gallons (115.4 liters)

THERMOSTAT

Quantity	2
Start to Open	180°F (82°C)
Fully Open	195°F (91°C)

RADIATORS

Manufacturer	Young
Quantity	2
Type	Fin & Tube
Location	Rear, Sides of Coach

BLOWERS

Gear Box Ratio	1:1
Gears	Spiral Bevel
Bearings	Tapered Roller
Gear Backlash	.003" - .004" (.076 mm - .101 mm)
Backlash Adjustment	Shims
Number of Fan Blades	36
Diameter	11¾" (29.8 cm)
Rotation	LH - Clockwise, RH - Counterclockwise
Blower to Housing Side Clearance	¼" (6.3 mm)
Blower Circumference to Housing Clearance	1⅛" (28.5 mm)

SHUTTERSTAT

Manufacturer	Kysor
Shutterstat Needle Travel	.0045" - .005" (.1143 mm - 1270 mm)
Part Number	6G-10-2
Temperature Range	190°F (87°C)

ALARMSTATS

Manufacturer	Kysor
Part Number	8G-28-7
Points Set to Close At	210°F (99°C)

OR

Part Number	8G-28-8
Points Set to Close At	220°F (104°C)

TEMPERATURE GAUGE (in engine compartment)

Manufacturer	Marsh
Part Number	8R-28-2
Operating Range	40° - 240°F (4° - 116°C)

TEMPERATURE GAUGE (on instrument panel)

Manufacturer	Stewart Warner
Part Number (Domestic Readings)	7K-13-8
(Metric Readings)	7K-13-15
Operating Range	100° - 250°F (38° - 121°C)

SPECIFICATIONS CONT'D

BLOWER BELT ADJUSTING AIR CYLINDER

Spring Free Travel	6.25" (158.75 mm)
Spring Load at 4.00" (101.6 mm)	180 lbs. ± 10% (81.648 kg ± 10%)
Spring Rate per Inch (25.4 mm)	80 lbs. ± 10% (36.288 kg ± 10%)
Piston O.D.	
Maximum Diameter	1.993" (50.622 mm)
Minimum Diameter	1.992" (50.598 mm)
Cylinder I.D.	
Maximum Diameter	2.0" (50.8 mm)
Minimum Diameter	1.996" (50.698 mm)

BLOWER DAMPER AIR CYLINDER

Cylinder I.D.	1.75" (44.45 mm)
Travel	1.375" (34.925 mm)
Piston Rod Length (From Center of Mounting Hole to Closed Position)	8.125 ± .0625" (206.375 ± 1.5875 mm)

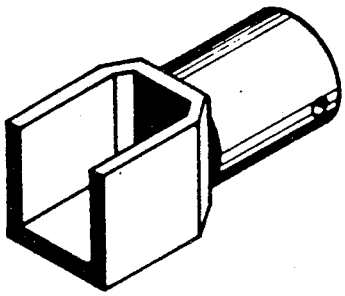
PRESSURE RELIEF VALVE (Surge Tank)

Manufacturer	A.C. Spark
Part Number	6R-8-49
Pressure Setting	7 psi (43 kPa)

SERVICE TOOLS

MANY OF THE TOOLS LISTED IN THIS SECTION ARE SPECIALLY DESIGNED TO MEET THE NEEDS OF VARIOUS SERVICE OPERATIONS. THEY ARE AVAILABLE FOR PURCHASE THROUGH MOTOR COACH INDUSTRIES, SERVICE PARTS DIVISION AND UNIVERSAL COACH PARTS OR, WHERE PRACTICAL, MAY BE MANUFACTURED BY THE OPERATOR. IN THESE CASES, DRAWINGS ARE AVAILABLE UPON REQUEST.

20-32 Socket — Tightening Water Line Elbows at Engine



20-60 Tool — Sight Gauge Gland Installation & Removal

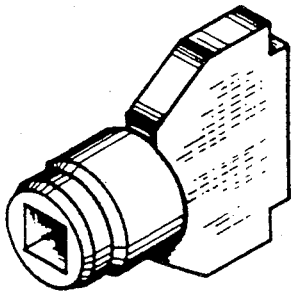


Figure 6-25. Service Tools.

Date 1-1-89

MC-9 MAINTENANCE MANUAL

SECTION 7
ELECTRICAL SYSTEM

SUBJECT	PAGE
Air Conditioning Junction Box Connections	7-33
Alarm Buzzers - Front Junction Box	7-11
Alarmstats	7-27
Alternator	7-2
Alternator Drive Plate Alignment	7-6
Alternator Geared Drive Adaoter	7-9
Batteries	7-21
Battery Charge Equalizer	7-25
Description	7-1
Electronic Speedometer	7-28
Engine Heaters	7-27
Front Junction Box Connections	7-34
Headlights	7-11
Horns	7-16
Light Bulb Data	7-32
Rear Junction Box Connections	7-36
Remote Control Box Connections	7-33
Safeguarding of Alternator and Coach Electrical Systems	7-8
Specifications	7-38
Starting Motor	7-15
Stop Lamps	7-11
Turn Signal Lamps	7-11
Twelve Volt Power Source	7-24
Triple Function Protective Device	7-25
Voltage Regulator	7-12
Voltmeter	7-11
Wiring Schematics Index	7-40
Service Bulletin Page	

MC-9 MAINTENANCE MANUAL

DESCRIPTION

The coach uses a 24 volt electrical system. A self-rectified alternator is gear driven from the engine and can be reached through the left side rear engine compartment door.

Wiring diagrams for the electrical system are included at the end of this section.



Figure 7-1. Battery Disconnect.

BATTERY DISCONNECT

A main battery disconnect switch is provided to shut off all electrical supply from the batteries. The switch is mounted on a vertical panel above the batteries and can be reached by opening the battery compartment door. To disconnect the batteries, pull knob down to OFF position. See figure 7-1.

TESTING CIRCUITS

A careful study of the wiring diagrams should be made to determine the source and flow of current through each electrical circuit. When a circuit is thoroughly understood, a point-to-point check can be made with the aid of the applicable wiring diagrams. Any circuit may be tested for continuity or shorts with a suitable volt-ohm meter.

All electrical connections must be kept clean and tight. Loose or corroded connections will cause discharged battery, difficult starting, dim lights, and improper functioning of other electrical equipment. Inspect all wiring connections at regular intervals. Make sure knurled nuts on all amphenol plugs are securely tightened.

CIRCUIT BREAKERS

All electrical circuits are protected by circuit breakers. The main circuit breaker and the two circuit breakers protecting the air conditioning system blower motors are located at the front of the baggage compartment and can be reached through the left front baggage door. See figure 7-2.

The main circuit breaker (105 amp) is an automatic reset type. The condenser motor (105 amp) must be manually reset.

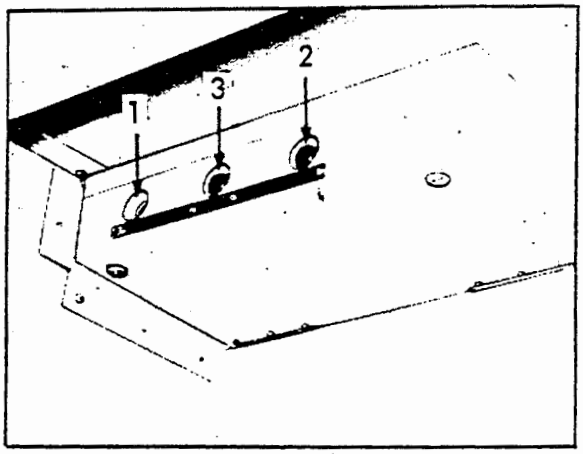


Figure 7-2. A/C Circuit Breaker in Left Front Baggage Compartment.

1. **Automatic Reset Circuit Breaker (105 Amp.)**
2. **Manual Reset Condenser Motor Circuit Breaker (105 Amp.)**
3. **Manual Reset Evaporator Motor Circuit Breaker (80 Amp.)**

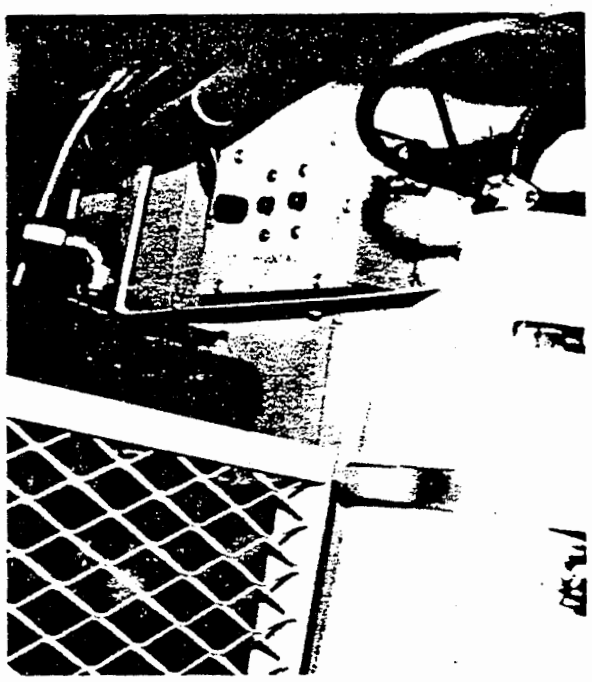


Figure 7-3. 110V In-Station Lighting Circuit Breaker Box in Left Front Service Compartment.

The evaporator motor circuit breaker is 80 amp. The evaporator motor circuit breaker is also a manual reset type.

Smaller circuit breakers of the self-resetting type are located in an external junction panel at the left hand front below driver's window and in a panel at the left hand rear engine compartment wall. When one of these circuit breakers opens due to a shorted circuit, it will automatically reset itself when the breaker element cools. As long as the short exists, the breaker will continue to open and close intermittently. In this case, turn the defective circuit off until the cause can be located and corrected.

The circuit breaker box for optional in-station lighting is mounted to the rear wall of the left hand front service compartment. See figure 7-3.

RELAYS

Relays are used to automatically energize or de-energize a circuit from a remote location. The relay draws a very low current to energize its coil. Once the coil is energized, it develops a magnetic field which will pull a switch arm closed or open to either energize or de-energize a given component. Because the control current required for the coil is very low, the relay allows a remote station (e.g. driver's switch panel) to control a high energy circuit without running great lengths of costly high capacity cable. With the use of a relay, the need for high amperage switches and heavy connectors is eliminated.

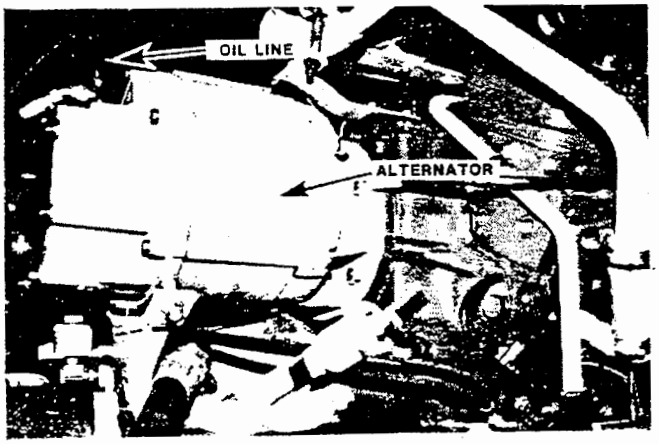


Figure 7-4. Alternator.

The MC-9 uses control relays for the Low and High Note Horns, Headlamps, Discharge and Blower cut-ins, Engine Stop, Stop Lights, Turn Lights, Reverse Solenoids, Starter Solenoid, Condenser and Evaporator Motor, Temp. & Level Sensors, Driver's Defroster, Step-Down Lamps at aisle, Alternator Field, and Heat Control Box.

NOTE: The relays should have the 5/16" stud nuts tightened to 50 ± 10 in. lbs. (5.6 ± Nm) torque.

GEAR DRIVEN ALTERNATOR — OIL COOLED

The gear driven, oil cooled alternator (figure 7-4) is a brushless, self-rectifying unit, in which all current carrying members, windings, diodes, and field coils are stationary. The only moving component is the rotor.

The oil-cooled alternator is a totally enclosed unit, cooled and lubricated by engine oil. The oil inlet is on the diode end cover, the oil drains back into the engine crankcase internally or through the drive end frame, drive adapter housing and the oil drain tube. The alternator should never be operated with the oil supply line disconnected. A continuous flow of engine oil flows through the alternator to lubricate the bearings and cool the assembly.

A relay or "R" terminal is tapped to energize a control relay in the electrical system.

CAUTION: The alternator is designed for use only on a negative ground system. If a positive ground battery is connected to the alternator, the alternator and wiring harness will be instantly destroyed. Always ensure that the alternator and batteries are negative ground. The alternator will not reverse to accept inverse polarity. Also, do not ground or short across any of the alternator or regulator terminals.

There are three components in the alternator which require electrical checks; the field winding, the six diodes, and the stator winding. See figure 7-5.

CAUTION: Before checking the alternator, turn off the battery disconnect switch.

FIELD WINDING — The field winding may be checked for shorts and opens with an ohmmeter. To check the field winding, connect the ohmmeter from the field terminal to ground. The normal resistance value is 3.0 to 3.3 ohms at 80°F. (27°C.). A resistance reading above normal indicates an open, and a reading less than normal indicates a short.

An alternate method of checking is to place a battery of specified voltage, and an ammeter in series with the field winding. The current should register 7.2 to 8.3 amperes at 24 volts.

A defective field can be replaced by removing the end frame on which the field terminal is located and then removing the four field coil mounting screws. See the section entitled Disassembly for a detailed procedure.

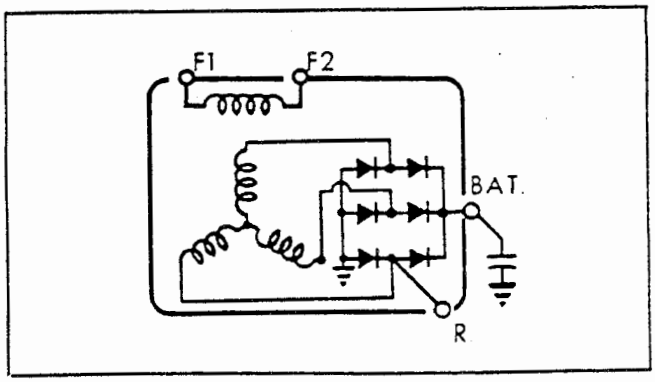


Figure 7-5. Alternator Wiring Diagram (Typical).

MC-9 MAINTENANCE MANUAL

CHECKING DIODES — Each diode may be checked for shorts and opens as follows:

1. Check to ensure the battery is disconnected.
2. Remove the pipe plug from underneath the end housing to drain the oil in the rectifier engine oil supply.
3. Remove the screws attaching the diode cover to the end housing.

CAUTION: Do not operate the alternator unless this unit is completely assembled.

4. Detach the DC terminals and relay terminal and disconnect the diode leads.

Each diode may be checked for shorts and opens with an ohmmeter as illustrated in figures 7-6, 7-7 and 7-8.

To check the diodes mounted in the diode supports for shorts, connect the ohmmeter positive lead to each diode lead and the onmmeter negative lead to each support as shown in A, B and C (figure 7-6). To check the diodes mounted in the end frame for shorts, connect the ohmmeter positive lead to each diode lead and the ohmmeter negative lead to the end frame as shown in D, E and F. Ohmmeter readings may vary considerably when checking diodes for shorts, but if the reading is 300 ohms or less, the diode is likely defective and should be replaced. If the diode reads 300 ohms or less, it will allow excessive reverse current from the battery.

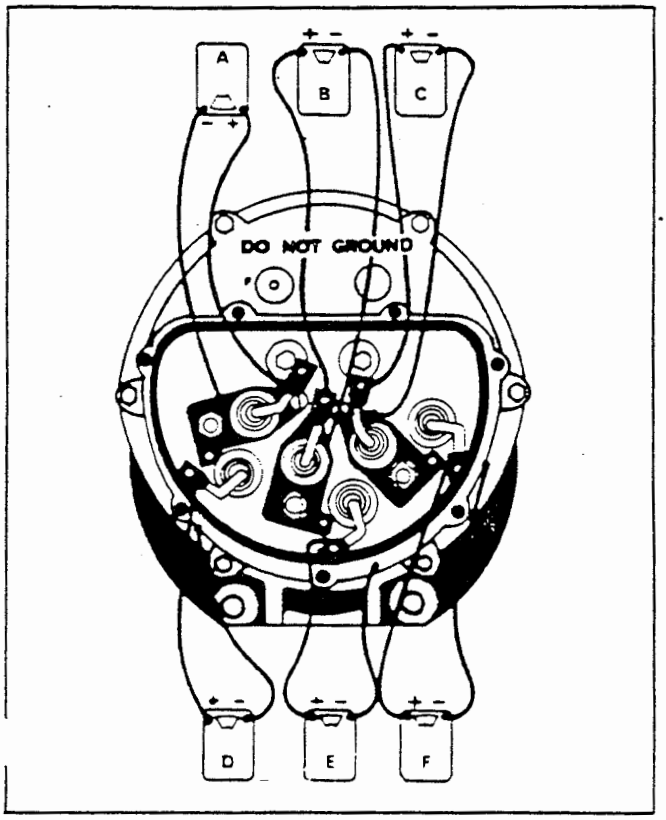


Figure 7-6. Checking Diodes for Opens Using Ohmmeter.

To check the diodes mounted in the diode supports for opens, connect the ohmmeter negative lead to each diode lead and the ohmmeter positive lead to each support as shown in A, B and C (figure 7-7). To check the diodes mounted in the end frame for shorts, connect the ohmmeter negative lead to each diode lead and the ohmmeter positive lead to the end frame as shown in D, E and F. An infinite resistance reading indicates an open diode.

Diodes can be replaced by following the procedure outlined in the section entitled Disassembly.

NOTE: When reinstalling diodes, tighten to 9-11 ft. lbs. (12-15 Nm) torque. Restake next to the threads in an arbor press with an ⅛" (3.2 mm) round punch. Press the punch with gradual pressure; do not strike as the shock may damage the diodes.

STATOR WINDING CHECKS — The stator windings may be checked for opens and shorts with an ohmmeter as follows (refer to figure 7-8):

OPENS: Connect the ohmmeter leads to two pairs of diode supports as shown in A and B (figure 7-8). The ohmmeter should show a low resistance. If a high or infinite resistance is measured in either one or both checks, the stator windings are open.

GROUNDS: To check for grounds, connect the ohmmeter as illustrated in C (figure 7-8). The ohmmeter should show a very high or infinite resistance. If zero or a very low resistance is measured, the windings are grounded.

The stator windings are difficult to check for shorts without finely calibrated laboratory test equipment due to the very low resistance values of the windings. However, if all other alternator checks are satisfactory, yet the unit fails to perform to specifications, shorted stator windings are likely.

MC-9 MAINTENANCE MANUAL

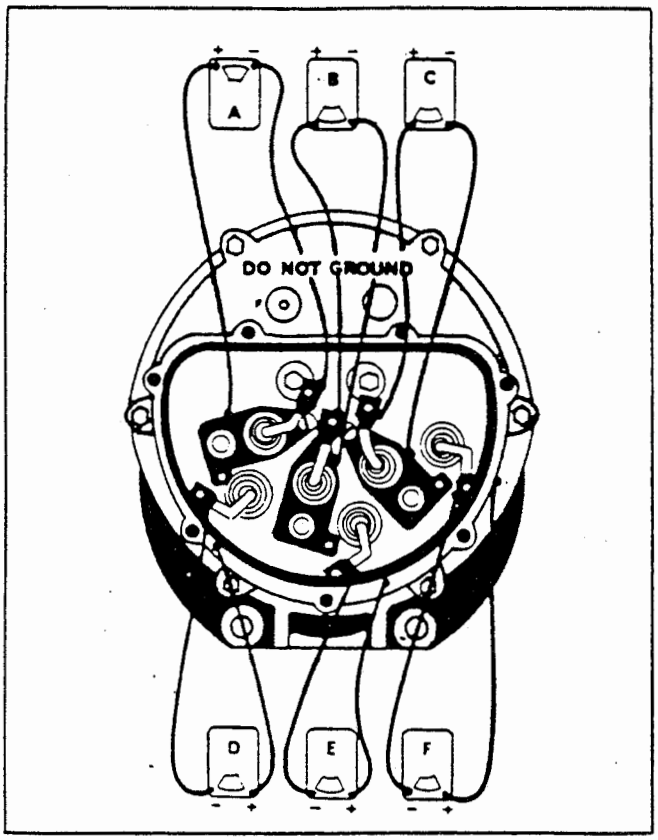


Figure 7-7. Checking Diodes for Shorts Using Ohmmeter.

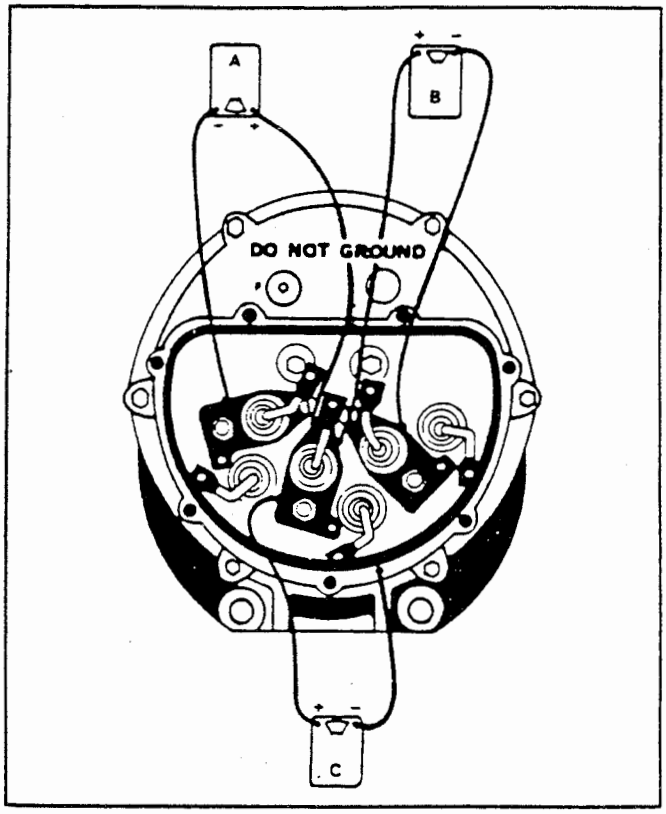


Figure 7-8. Checking Stator Windings for Opens and Grounds.

DISASSEMBLY

The alternator may be disassembled by following the steps below; refer to figure 7-9:

1. Remove nuts and washers from DC terminal on diode end frame.
2. Separate the diode cover plate (3) from the diode end frame by removing mounting screws (1).
3. Remove the washer, nut and lock washer attaching the diode supports to the end frame, the three screws (5) connecting the diode leads to the diode supports, and the three nuts (4) which attach the stator studs to the diode supports.
4. Separate the diode support assemblies from the diode end frame, and the three nuts (6) which connect the studs to the diode end frame.
5. Mark the position of the drive end frame and diode frame with respect to the stator assembly so that the parts can be reassembled in the same position.
6. Detach the diode end frame and field assembly from the stator assembly by removing the attaching screws (13).
7. Separate the field assembly from the diode end frame by removing the four attaching screws (11).
8. Separate the rotor assembly and drive end frame from the stator assembly by removing the attaching screws (25).
9. Remove the shaft nut and washer, and the pinion gear. Press the rotor shaft out of the drive end frame.
10. Remove the retainer plate (20) and pull the bearings from the drive end frame.

NOTE: When tightening the outside nut on the DC output terminal, torque the nut to 30-35 ft. lbs. (41-47 Nm). The lower nut should be held secure while tightening the top nut.

REASSEMBLY

Reassembly is the reverse of disassembly. When installing the single row bearing into the drive and frame, press against the outer race only to avoid loading the bearings. Attach the bearing retainer plate, and press against the bearing inner race to force the assembly over the shaft. To avoid pressure on the bronze ring in the rotor, support the inside of the rotor against the shaft, and place the shaft in an upright position to facilitate the assembly procedure. Press against the inner race to force the double row bearing over the shaft. When attaching the field to the diode end frame, make sure the mating surfaces are perfectly clean and tighten the mounting screw securely.

NOTE: When reinstalling diodes, tighten to 9-11 ft. lbs. (12-15 Nm) torque.

MC-9 MAINTENANCE MANUAL

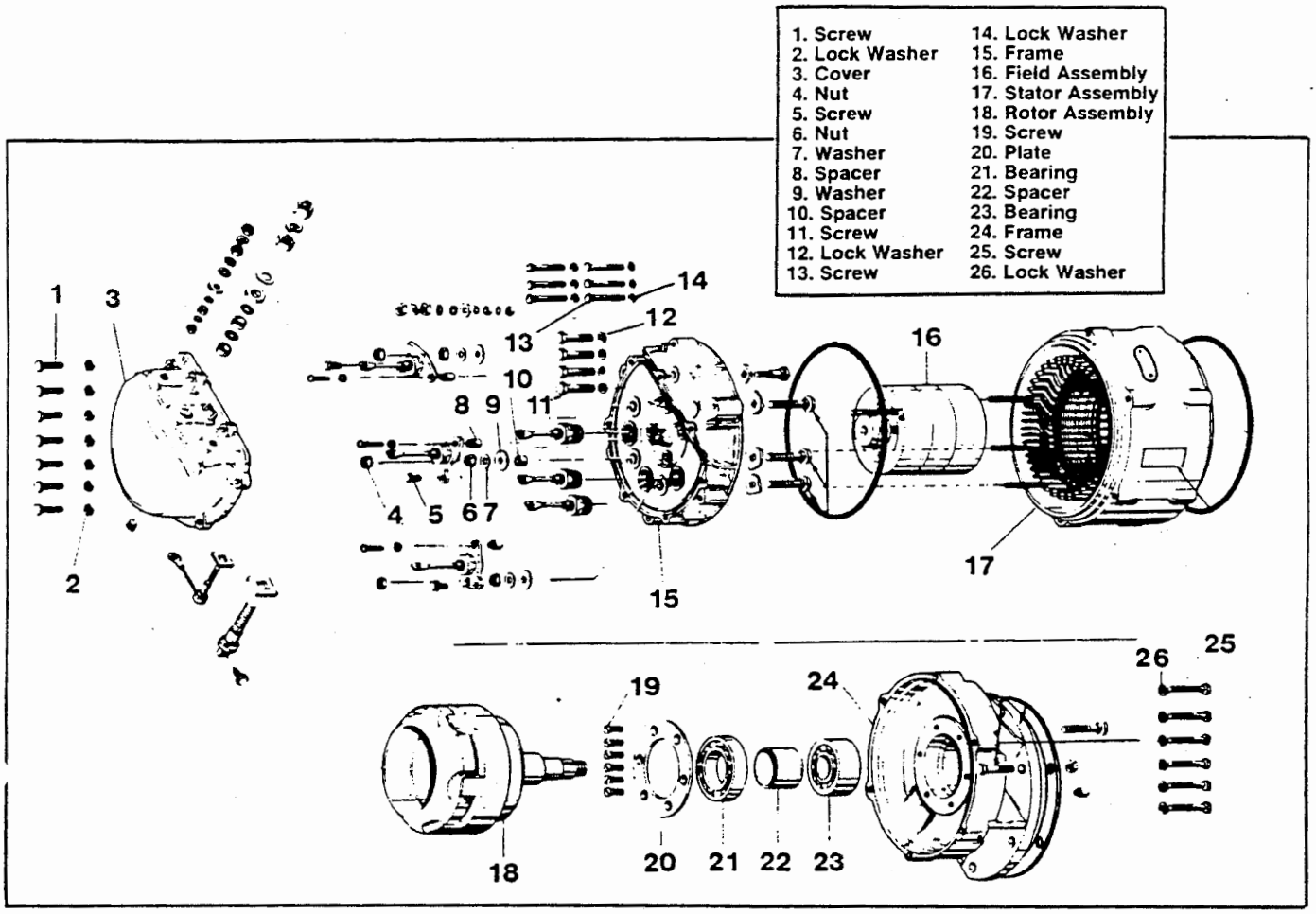


Figure 7-9. Alternator Components.

OUTPUT CHECK

When removed from the engine, the alternator may be checked on a test bench without circulating oil, providing the output is limited to 100 amperes or less. The alternator may be checked without circulating oil at outputs exceeding 100 amperes as long as the period of operation is limited to less than 15 seconds.

CAUTION: Operating the alternator at outputs greater than 100 amperes for periods exceeding 15 seconds will cause the alternator to overheat, resulting in damage to the winding and diodes.

REMOVING ALTERNATOR

1. Disconnect electrical wiring at the diode end frame.
2. Disconnect oil supply lines at the diode end frame. If alternator has an oil drain tube, disconnect it at the engine. Refer to figures 7-10 and 7-11.
3. Remove the nuts and washers from the studs mounting the alternator. Pull alternator straight off mounting studs. To remove the alternator drive gear housing (if so equipped), remove the five allen-head capscrews; if equipped with a "figure-8 adapter," it is removed by removing the four upper adapter mounting bolts.

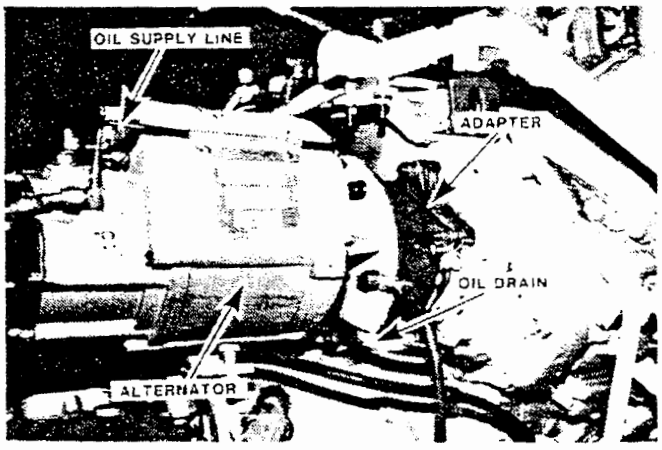


Figure 7-10. Alternator With Adapter.

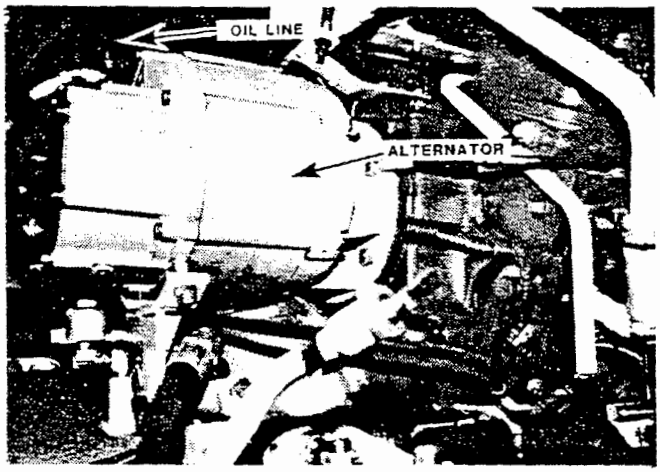


Figure 7-11. Alternator Without Adapter.

ALIGNMENT OF 21-TOOTH DRIVE PLATE (NUT MOUNTED CAM GEAR)

1. Check the concentricity of drive plate by placing pin of tool 20-157 (figure 7-12) into pilot hole in camshaft. If shoulder of 20-157 will fit inside the teeth of the 21-tooth drive plate proceed to Alignment of Adapter Plate (1).

2. Mount drive plate loosely on camshaft gear (or loosen capscrews if plate is already mounted). Place tool 20-157 into center bore of camshaft to center the drive plate. See figure 7-12. Tighten capscrews to 40-45 lb. ft. (54-61 Nm) torque. Capscrews are accessed through notches in 20-157 alignment tool. Remove alignment tool.

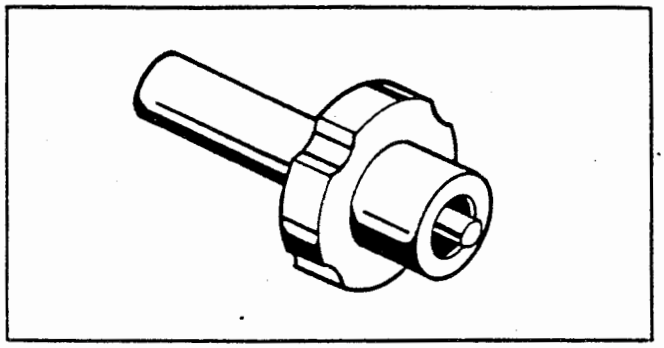


Figure 7-12. Alignment Tool 20-157 (Nut-Mounted Cam Gear).

ALIGNMENT OF 21-TOOTH DRIVE PLATE (CAPSCREW MOUNT CAM GEAR)

1. Remove capscrew and washer that mount cam gear to camshaft. Install alignment washer (20-286), 5142501 coupling gear and capscrew inside 21-tooth drive plate. Refer to figure 7-13. Shoulder on washer fits inside bore of cam gear. Snug up capscrew tightly.

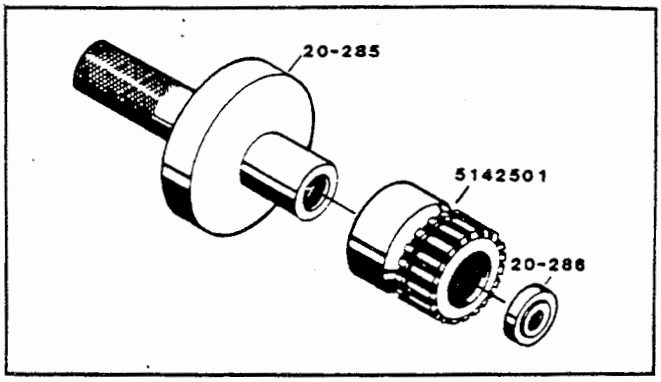


Figure 7-13. Alignment Tool (Capscrew-Mounted Cam Gear).

ALIGNMENT OF ADAPTER PLATE (1)

NOTE: This procedure (1) is followed when the 21-tooth drive plate is mounted with a lock washer and nut. If a capscrew is used to mount the drive plate, go to the next procedure (2).

1. Mount the gasket and adapter plate on the flywheel housing loosely, using the five allen head capscrews. Loosen the screws if plate is already mounted.



Figure 7-14. Aligning Adapter Plate.

2. Place tool 20-157 into center bore of camshaft to center adapter plate. See figure 7-14. Tighten the four ½" allen head capscrews to 78-80 lb. ft. (105-108 Nm) torque. Tighten the one 7/16" allen head capscrew to 55-60 lb. ft. (75-81 Nm) torque. Remove tool 20-157.

ALIGNMENT OF ADAPTER PLATE (2)

NOTE: This procedure (2) is followed when the cam gear is mounted with a capscrew and washer.

1. Mount gasket and adapter plate on flywheel housing loosely, using the five allen-head capscrews.

2 Remove capscrew and washer mounting cam gear to camshaft. Install alignment washer 20-286, DDA coupling 5142501, and original capscrew. The shoulder on the washer 20-286 fits inside the bore of the cam gear. Coupling 5142501 fits between the washer 20-286 and the 21-tooth plate. Install capscrew and snug up tightly.

3. Insert alignment tool 20-285 inside coupling until the tapered shoulder touches the alternator adapter plate.

4. With adapter plate located properly using tool 20-285 tighten the four ½" allen-head capscrews to 78-80 lb-ft torque (105-108 Nm). Tighten the one 7/16" capscrew to 50-55 lb-ft torque (68-74 Nm). Remove tooling group 20-285 20-286, 5142501.

5. Replace the original washer and capscrew, tighten capscrew to 180-190 lb-ft (244-258 Nm).

INSTALLATION OF ADAPTER HOUSING AND ALTERNATOR

NOTE: This procedure is followed when a geared adapter housing is used to drive the alternator. If the alternator is mounted to the engine without the geared adapter housing, refer to Installation of Alternator without Geared Adapter Housing.

1. Place the adapter housing and gasket over the adapter studs and tighten nuts to 70-75 lb. ft. (95-102 Nm) torque.

NOTE: Coat gasket with Permatex before installation.

2. Mount the alternator and gasket onto the adapter housing studs and tighten to 70-7b lb. ft. (95-102 Nm) torque.

3. Install the oil feed lines and tighten the oil drain tube at the engine.

4. Install the electrical connections at the diode end frame.

5. Run the engine and check alternator output and for oil leaks.

ALTERNATOR WITH "FIGURE 8" ADAPTER PLATE

Later production coaches do not have the alternator adapter; the alternator is a direct mount type. A "figure 8" adapter plate is used with this later installation.

REMOVING ALTERNATOR

1. Disconnect electrical wiring at the diode end frame.
2. Disconnect oil supply lines at the diode end frame.
3. Remove the nuts and washers from the studs mounting the alternator. Pull alternator straight off mounting studs. Remove the "figure-8 adapter" by removing the four upper adapter mounting bolts.

INSTALLING AND ALIGNING OF ALTERNATOR ADAPTER (FIGURE-8 ADAPTER)

The alternator is attached to the engine by the use of an adapter which has a figure "8" shape. The adapter is installed and aligned prior to installation of the alternator.

1. Position gasket and "figure-8 adapter" on flywheel housing. See Fig. 7-14A.

NOTE: Gasket must have notch at inside edge of large circle for proper internal oil drainage.

2. Center the figure-8 adapter over cam gear using feeler gauge or other means. Install and tighten the four upper adapter bolts to 45-50 lb. ft. (54-61 Nm). torque. Adjust the two set screws to contact flywheel housing.

3. Place magnetic base (for dial indicator) on the hex-head capscrew mounting cam gear to camshaft. Install dial indicator on base and set stylus to contact inside edge of figure-8 adapter bore. Set dial indicator to zero. See Fig. 7-14B.

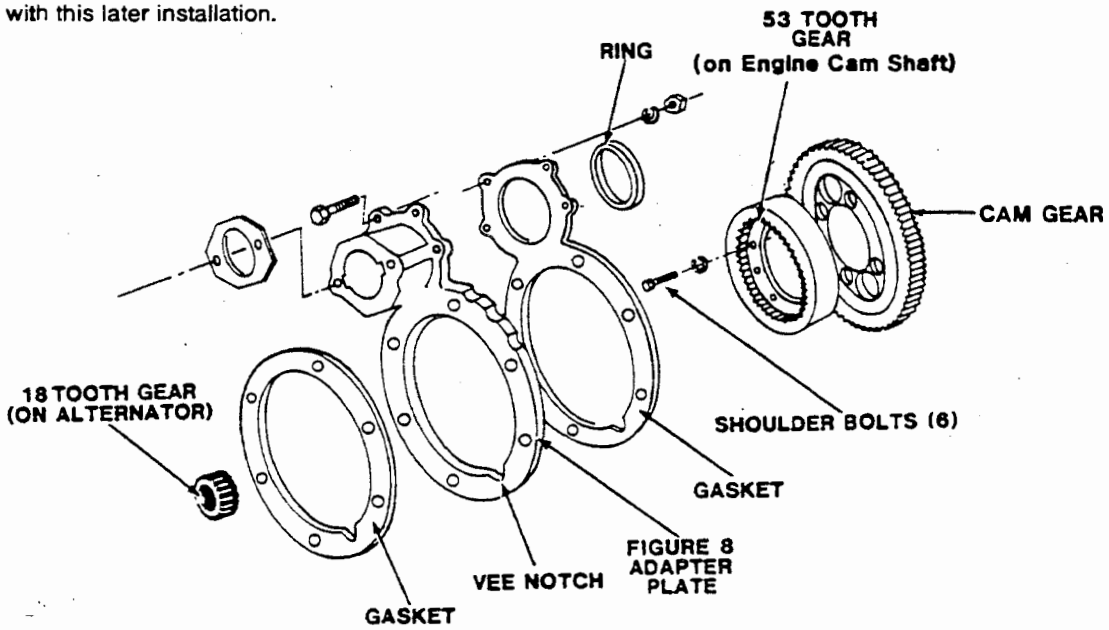


Figure 7-14A. Alternator Mounting Adapter.

NOTE: A tool is available which quickly mounts a dial indicator on the 53-tooth alternator drive gear for alignment of figure-8 adapter. This tool is available from Kent-Moore Corporation Service Tool Division or through a Detroit Diesel Allison distributor. The Kent-Moore tool number is J29893. See Fig. 7-14C.

CAUTION: Engine must always be rotated in a clockwise direction when viewed from engine front. Barring the engine in the wrong direction will loosen the crankshaft end bolt. Engine damage will result when engine is started. An assistant is necessary to bar engine over while dial indicator is read.

4. Bar engine over. Dial indicator must rotate clockwise at least 180° of one revolution. The figure-8 adapter is centered if dial indicator reads within ±.002 TIR. If satisfactory, proceed to step 6.

5. If runout is more than ±.002 TIR, loosen the four upper adapter bolts. Back off the two set screws and readjust them until dial indicator reads within tolerance when engine is barred over. Repeat the procedure until the required reading is attained, or until it is determined that the figure-8 housing is out-of-round or otherwise defective. Replace as necessary.

6. Remove dial indicator and magnetic base. Tighten the four upper mounting bolts to 40-45 lb. ft. (54-61 Nm) torque.

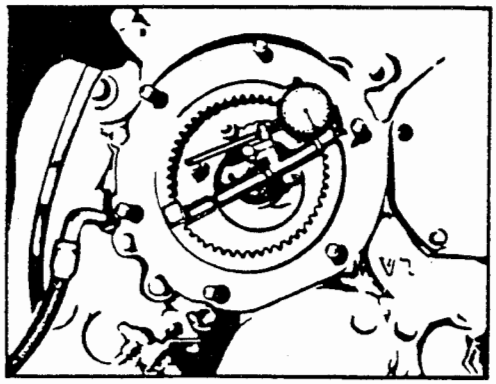


Figure 7-14B. Dial Indicator Installed.

INSTALLATION OF ALTERNATOR ON FIGURE-8 ADAPTER

1. Position the alternator and gasket on the mounting studs.

NOTE: Gasket must have a notch at inside edge of large circle for proper internal oil drainage. Coat gasket with a thin coat of Permatex before installation. Use sparingly, especially in area of notch at bottom.

2. Install nuts on studs and tighten to 70-75 lb. ft. (95-102 Nm) torque.

3. Install oil feed line and electrical connections at the diode end frame.

4. Run the engine and check alternator output and for oil leaks.

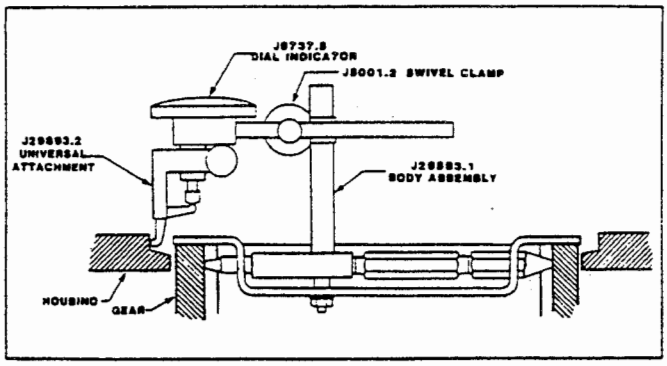


Figure 7-14C. Dial Indicator and Mounting Tool.

SAFEGUARDING OF ALTERNATOR AND COACH ELECTRICAL SYSTEMS

The following general procedures are important in protecting the alternator, voltage regulator and other electrical or electronic systems on the coach.

1. After installing a new or rebuilt alternator, make certain that all wiring to the alternator and to the voltage regulator is completely installed before attempting engine start-up.

2. Do not remove any wires or cables from the alternator or from the voltage regulator while the battery disconnect switch is "ON".

3. Do not perform welding operations on the coach without following the steps listed in the "WELDING CAUTION" in the Introduction to this manual.

A further series of steps to be taken to protect the alternator from damage when initially starting a newly installed engine are listed below. When a new or rebuilt engine is first started, it may stall due to lack of prime in the fuel system. When the engine stalls, built-up compression may induce roll back in the engine causing the alternator to reverse direction and thereby produce a negative voltage spike. This negative spike could burn out a transistor in the voltage regulator making it ineffective in protecting the alternator.

Initial Engine Start-up Procedures

1. Make sure field relay is removed (refer to rear junction box decals in the later pages of this section for the field relay location).
2. Turn **all** dash switches off.
3. Turn battery disconnect switch "ON".
4. Turn master switch "ON".
5. Fuel prime and start engine.
6. Run engine for five minutes.
7. Stop engine.
8. Turn master switch "OFF".
9. Turn battery disconnect switch "OFF".
10. Install field relay in rear junction box.
11. Turn battery disconnect switch "ON".
12. Turn master switch "ON".
13. Restart engine using normal start-up procedures.

MC-9 MAINTENANCE MANUAL

SERVICING ALTERNATOR GEARED DRIVE ADAPTER

The alternator drive adapter should be inspected every time the alternator is removed, or when its condition is suspect:

1. Remove the alternator.
2. Remove the five nuts and washers that secure the adapter housing to the adapter plate.
3. Pull housing straight off studs.

Once the housing is removed, rotate and check the end play of the shaft to check condition of bearings. Inspect drive gear for worn or chipped teeth. If condition of bearings, shaft, or gear is questionable, replacement is necessary.

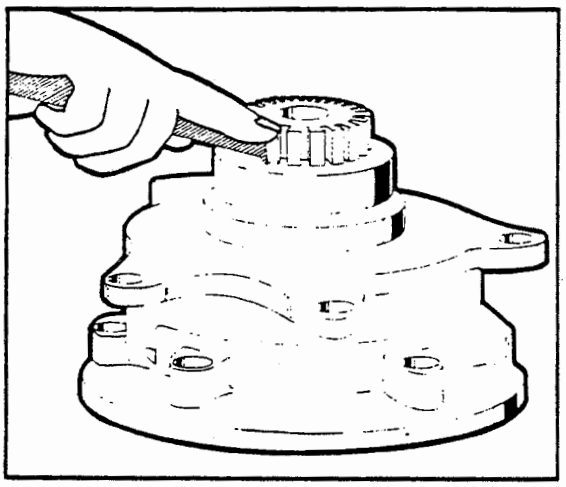


Figure 7-15. Retaining Ring Removal.

DISASSEMBLY

1 Remove self-locking nut from drive gear shaft.
2. Remove bearing retaining ring from the adapter housing. (Do not remove retaining ring from shaft.) (Figure 7-15).
3. Support the adapter housing on steel blocks on the bed of a hydraulic press and press the drive shaft out of the drive gear bore (figures 7-16 and 7-17).
4. Remove the Woodruff key from the drive shaft.
5. Install a bearing separator between the lower bearing and the drive spline and retaining ring (figure 7-18).
6. Support the bearing separator on steel blocks on the bed of a hydraulic press. Press the drive shaft out of the bearing races.
7. Thoroughly clean all parts before reassembly. See figure 7-19.

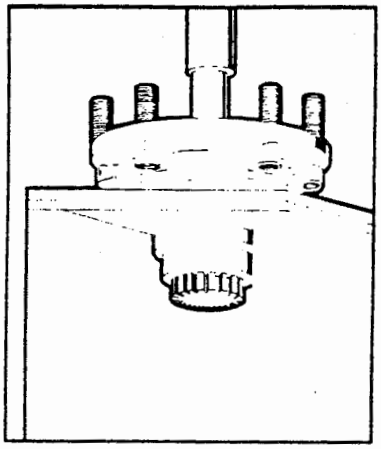


Figure 7-16. Adapter Housing Support.

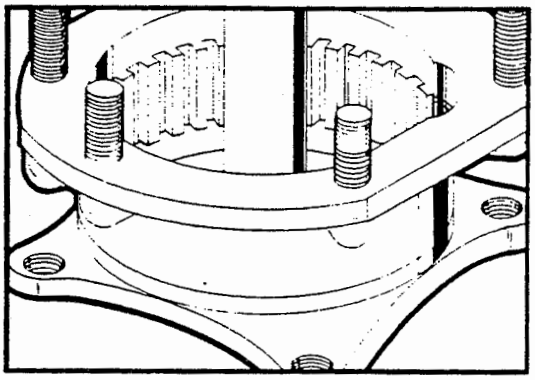


Figure 7-17. Drive Gear Removal from Drive Gear Bore.

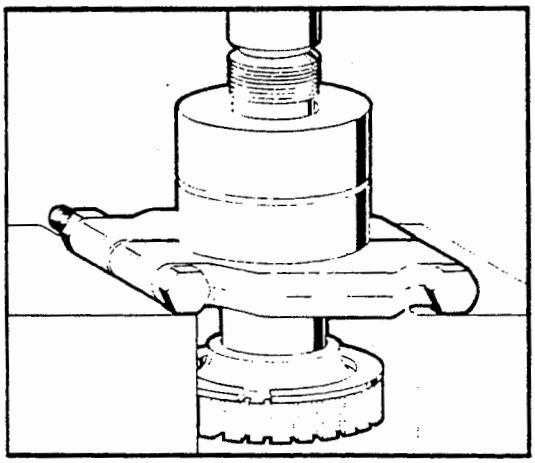
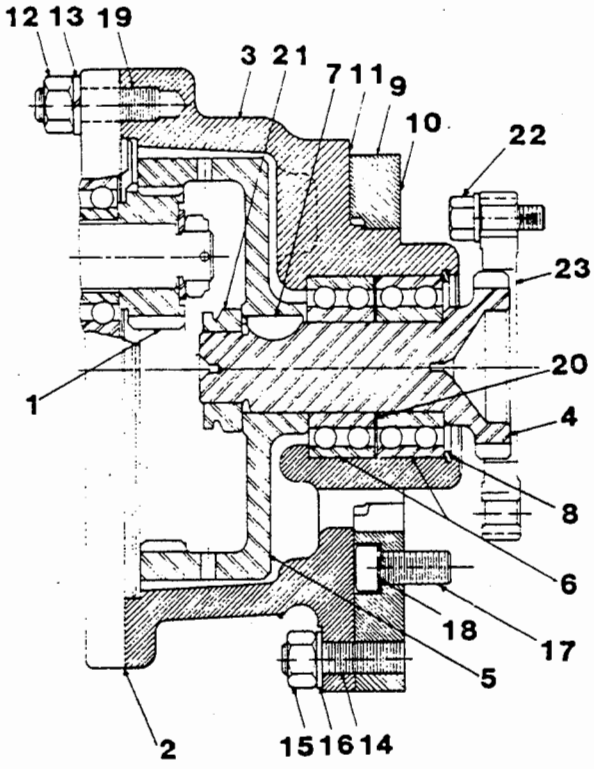


Figure 7-18. Drive Shaft Removal.

MC-9 MAINTENANCE MANUAL



1. Gear Pinion
2. Gasket
3. Housing
4. Alternator Drive Shaft
5. Alternator Drive Gear
6. Alternator Drive Bearing
7. Key
8. Retaining Ring
9. Adapter Plate
10. Gasket
11. Gasket
12. Nut
13. Lock Washer
14. Stud
15. Nut
16. Lock Washer
17. Capscrew
18. Lock Washer
19. Stud
20. Spacer
21. Drive Gear Shaft Nut
22. Bolt
23. Drive Plate

Figure 7-19. Gear-Driven Alternator Drive Adapter (Cross Section).

REASSEMBLY

1. Place the retaining ring on the shaft and set the shaft on the bed of a hydraulic press.

2. Position one of the bearings on the shaft. Using a hollow bearing mandrel, figure 7-20, press the bearing onto the shaft until it bottoms. Install the bearing spacer, figure 7-21, and press the second bearing onto the shaft in the same manner.

NOTE: A length of steel pipe, 4.5" (114.3 mm) long with an inner diameter of 1.5" (38.1 mm) and a wall thickness of .25" (6.35 mm) will serve as a bearing mandrel.

3. Using a soft hammer, install the Woodruff key into the shaft. Figure 7-22 shows the shaft complete with retaining ring, bearings and Woodruff key installed.

4. Install the shaft and bearing assembly into the alternator drive adapter housing through the engine side of the housing (figure 7-23).

5. Install the retaining ring into the groove of the housing.

6. Support the adapter housing on steel blocks to prevent it from moving while installing the gear onto the shaft.

7. Carefully install the gear onto the shaft ensuring that they are perfectly aligned.

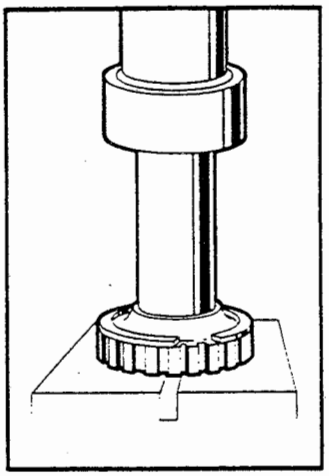


Figure 7-20. Bearing Installation.

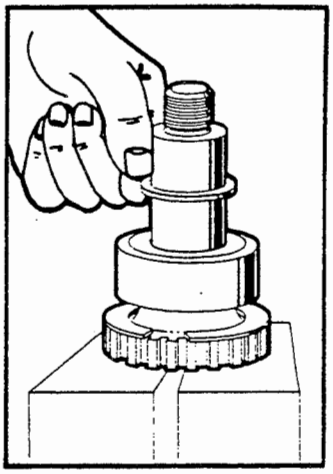


Figure 7-21. Spacer Placement.

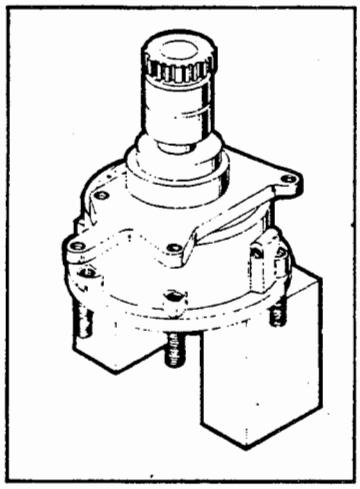


Figure 7-22. Shaft Assembly.

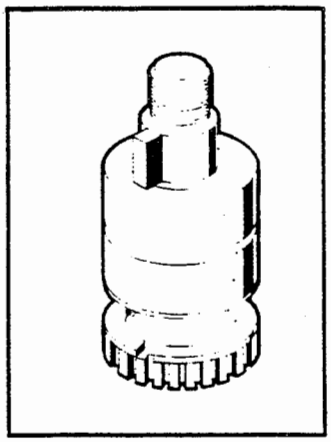


Figure 7-23. Shaft Assembly Installed.

MC-9 MAINTENANCE MANUAL

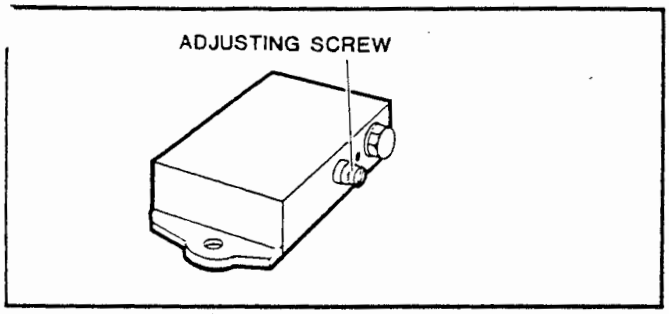


Figure 7-24. Alarm Buzzer.

ALARM BUZZERS

The alarm system buzzers are mounted in a sealed, external junction box below the driver's window. The buzzers are for low air, hot engine, low water, and low oil pressure conditions.

NOTE: Activate each circuit and adjust buzzer for desired sound. To increase sound, turn adjusting screw clockwise; counterclockwise to decrease. Refer to figure 7-24 for adjusting screw.

The manufacturer's specified range is between 65 and 75 decibels. The factory setting is 75 decibels.

VOLTMETER

A voltmeter is installed in the lower center opening of the instrument panel cluster to provide a voltage system reading. Refer to wiring diagram at the end of this section.

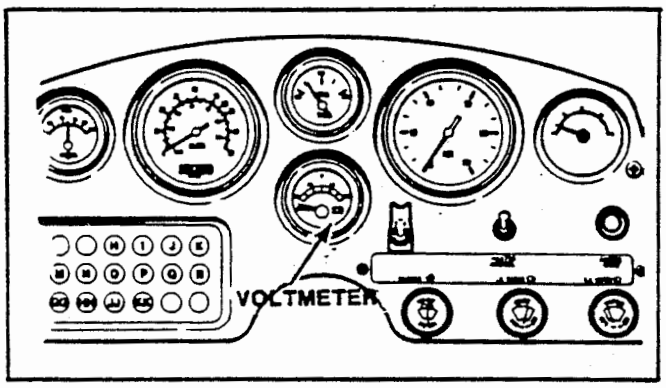


Figure 7-24A. Voltmeter.

TURN SIGNAL & TAIL LAMPS

The stop, turn signal and tail lamps are mounted in castings at the rear corners of the coach.

The turn signal lamps are amber colored; the tail lamps are ed. Both of these units are sealed and are serviced as units; there is no bulb or lens. These units are held in the casting by means of a heavy rubber gasket, and are simply snapped in or out of the gasket.

STOP LAMPS

The stop lamps each consist of a spring-loaded socket for the bulb, and a red reflective lens housing. To service the bulb, remove the 4 screws which mount the lens housing to the casting, pull out the lens and remove the socket from the rear of the lens. To remove the socket from the lens housing, push the socket inward, and twist it until the tangs on the socket are in line with the slots in the lens housing. The socket will now pop out. The bulb is removed in a similar fashion from the socket. Push the bulb downward into the socket, and twist it a quarter turn. Release pressure against the bulb and it should be free. See lamp specifications at end of this section for correct replacement bulb.

The stop lamps are illuminated when the service brakes are applied.

HEADLIGHTS

DESCRIPTION

The headlights are double filament "sealed beam" type and operate on a 12V circuit.

Switch marked "Headlights" mounted in the driver's switch panel to the left of the driver controls headlights. High or low headlight beam is selected by means of a floor-mounted dimmer switch. When high beams are on, a tell-tale light marked "Hi Beam" on the instrument panel will glow.

MAINTENANCE

Clean with water and a good glass cleaner whenever dirty.

For maximum illumination headlamps must not be blackened and proper voltage must be maintained. Low battery, loose or dirty electrical contacts in wiring system and poor ground all contribute to a decrease in voltage. Check wiring and connections regularly and keep battery properly charged. When headlamp burns out, a complete new sealed beam unit must be installed.

REMOVAL

Remove bezel retaining screws and remove bezel. Removing three screws which hold sealed beam unit in housing. Pull unit out of housing. Disconnect plug-in socket. Install new sealed beam unit reversing above procedure.

HEADLIGHT ADJUSTMENT

Headlights must be aimed carefully and accurately to assure safe vehicle operation at night. Adjustments can be made quickly and accurately with a headlight tester. However, if equipment is not available, make adjustments as described below.

(A) Place vehicle on level floor so headlights are 25 feet (7.6 m) from a smooth vertical surface perferably of light color. A door or wall is suitable. Center line of vehicle should be perpendicular to this vertical surface.

(B) Draw a horizontal line on vertical surface at height of light center. Locate point on this horizontal line at which projected centerline of vehicle intersects. Measure distance between lamp centers and divide this distance equally on either side of center mark. Then draw two vertical lines directly ahead of each light center.

(C) Switch on high beam and cover one light adjusting other.

(D) Remove light bezel retaining screws and aim light beam with adjusting screws. Top screw provides horizontal adjustment.

(E) When aiming headlights, beam may appear distorted. A new sealed beam unit must be installed to correct this condition.

(F) After headlight is properly aligned, cover its beam and proceed in same manner as above with opposite light.

VOLTAGE REGULATOR

The voltage regulator illustrated in figure 7-25 is an assembly composed principally of capacitors, resistors and transistors. These components are mounted on a printed circuit board to form a static unit containing no moving parts. Regulators of this type have terminals marked NEG, FLD and POS.

The regulator limits the alternator voltage to a pre-set value by controlling the alternator field current. This is the only function the regulator performs in the charging system.

The voltage at which the alternator operates is determined by the regulator adjustment. Once adjusted, the alternator voltage remains constant, since the regulator is unaffected by length of service, changes in temperature, or changes in alternator output and speed.

A typical wiring diagram of a negative ground system is illustrated in figure 7-26. This diagram shows only the basic charging system components, and does not show other components such as control relays.

TROUBLESHOOTING

Trouble in the charging system will usually be indicated by undercharged or overcharged batteries. Either condition can result from an improper voltage regulator setting.

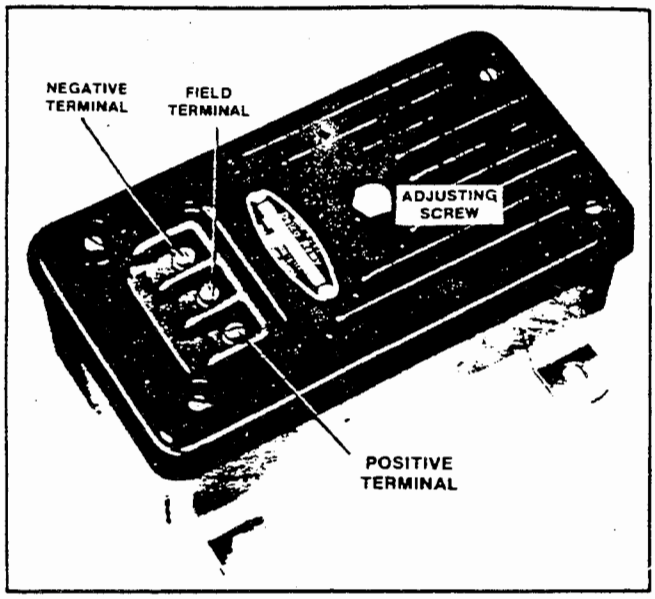


Figure 7-25. Voltage Regulator.

The ideal voltage setting is the one which will maintain the batteries in a fully charged condition with a minimum depletion of water. A record of water usage and battery specific gravity checks over a service period of reasonable length will establish the ideal voltage setting for the vehicle involved. Where maintenance-free batteries are used, the absence of gassing and the continuous appearance of the green dot in the built-in hydrometer indicate the regulator voltage setting is satisfactory.

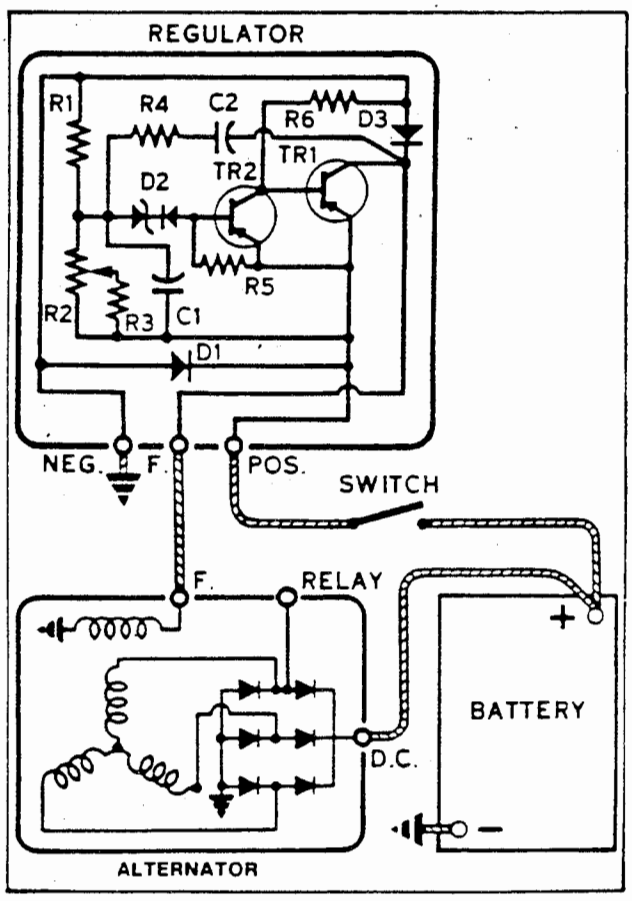


Figure 7-26. Charging System Diagram.

MC-9 MAINTENANCE MANUAL

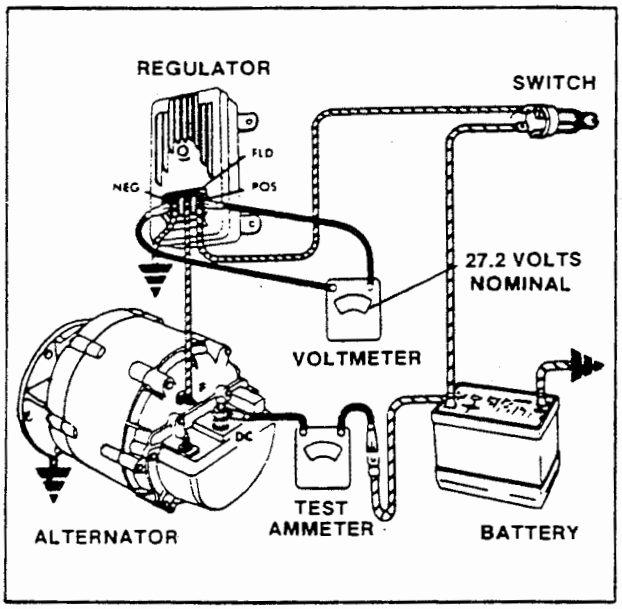


Figure 7-27. Voltage Regulator Adjustment Setup.

VOLTAGE REGULATOR SETTING

To check the voltage setting, connect a voltmeter across the POS and NEG terminals on the regulator and an ammeter at the DC terminal on the alternator (figure 7-27). Operate the engine at approximately 1,000 RPM (about 2,300 alternator RPM) with accessories turned on to obtain 20-200 amperes alternator output and note the voltage setting. The voltage should be steady and reasonably close to 27.2 volts, nominal. Desired variations from the published setting can be obtained by removing the plug from the voltage regulator cover and turning the adjusting screw inside the regulator (figure 7-28). This will change the voltage to meet the needs of vehicle as dictated by operating conditions.

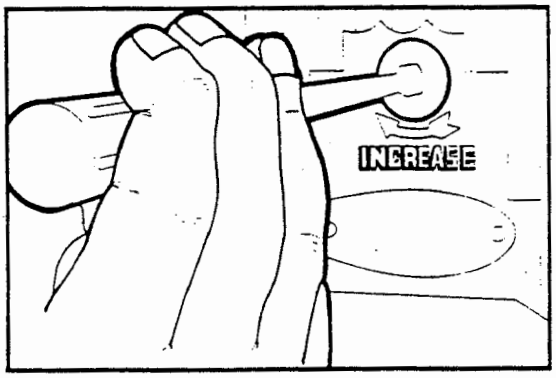


Figure 7-28. Adjusting Voltage Regulator.

If the voltage setting as checked above is steady and reasonably close to the specified value and the battery is undercharged, raise the setting by .3 volt and check for an improved battery condition over a minimum service period of 48 hours. If the voltage cannot be adjusted to the desired value, the alternator should be checked as follows:

1. Stop alternator, turn off all accessories and disconnect battery ground cable.
2. Disconnect all leads from the alternator and from the alternator field.

CAUTION: Do not allow leads to touch vehicle ground.

3. Connect a voltmeter and ammeter in the circuit at the DC terminal on the alternator.
4. Connect a jumper lead from the alternator DC terminal to the field terminal. If two field terminals are used, ground the other field terminal.
5. Connect a carbon pile load across the battery. Turn to off position.
6. See figure 7-29 for wiring connections.
7. Reconnect battery ground cable.
8. Turn on all vehicle accessories.
9. Operate alternator and adjust carbon pile load as required for output of 80 amps at 1,200 RPM or 225 amps at 2,500 RPM (cold).
10. Check the alternator field winding as follows:

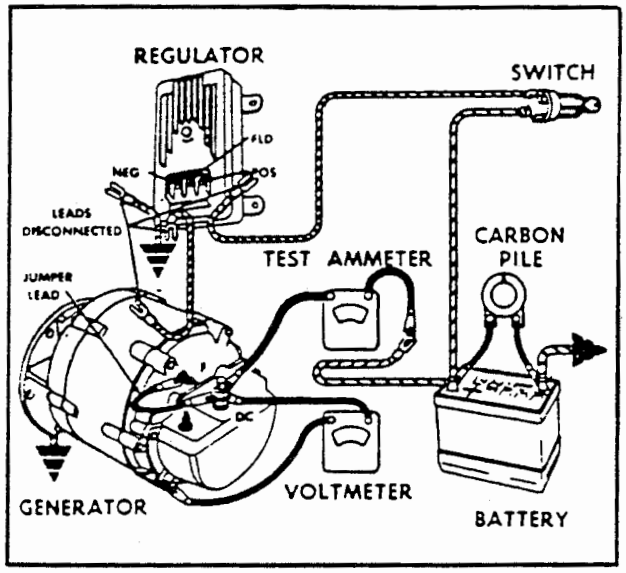


Figure 7-29. Alternator Output Test Setup.

Alternators with one field terminal — Disconnect the lead from the field terminal and connect an ohmmeter from the field terminal to ground. For alternators with two field terminals, disconnect all leads from the field terminals and connect an ohmmeter across the terminals.

A resistance reading above normal indicates an open, and a resistance reading less than normal indicates a short or ground. The normal resistance can be calculated by dividing the indicated voltage by the field current rating of 5.95V ± .25V. The normal resistance value should be at or near midscale on the ohmmeter for accuracy.

An alternate method of checking is to connect a battery of specified voltage and an ammeter in series with the field winding and compare readings with published specifications in Delco-Remy Service Bulletin 1G-186, 1G-187 or 1G-188.

To check for a ground, connect the ohmmeter from either field terminal to ground. A reading equal to or less than the normal resistance value indicates a ground.

The alternator is defective if it does not produce rated output or if field windings are faulty. If the alternator provides rated output and field windings check satisfactorily, the regulator should be checked as covered under Regulator Checks.

MC-9 MAINTENANCE MANUAL

If the voltage setting as checked above is steady and reasonably close to the specified value, lower the setting by .3 volt and check for an improved battery condition over a minimum service period of 48 hours. If the voltage cannot be adjusted to the desired value, proceed as follows: where the alternator field is grounded internally in the alternator as shown in figure 7-26, a shorted or grounded field or a defective regulator can cause an overcharged battery. The field winding can be checked as above. If the field winding is found not to be defective, the generator is not defective, and the regulator should be checked as covered in section entitled Regulator Checks.

REGULATOR CHECKS

Refer to figure 7-25. Separate the cover from the base, and then remove the panel assembly from the cover. Carefully note the location of all washers and lock washers.

Before making electrical checks, visually inspect the components and make sure all soldered connections are secure. Various electrical checks with an ohmmeter can be made to determine which components are defective.

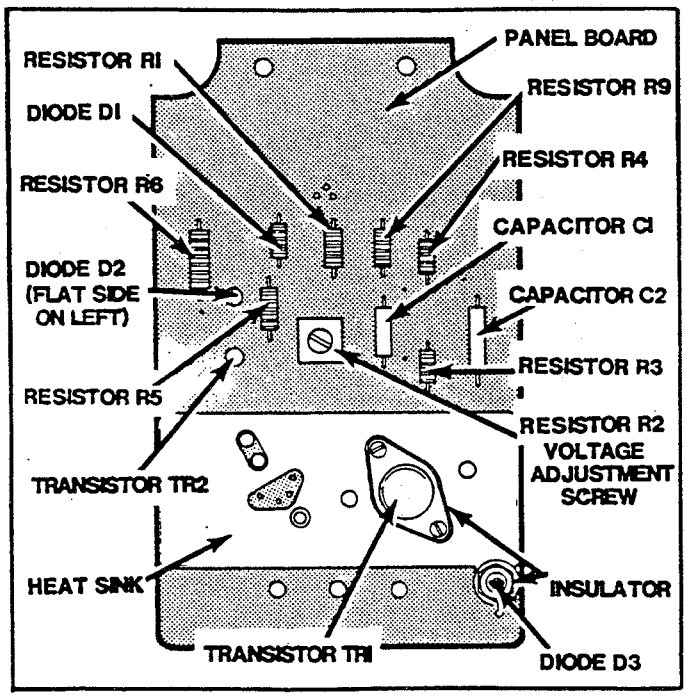


Figure 7-30. Regulator Components.

The component parts are identified in figure 7-30, and are keyed to figure 7-26. Resistor R9 may not be used on 24-volt systems. Before making electrical checks, visually inspect the components and make sure all soldered connections are secure. Various electrical checks with a ohmmeter can be made to determine which components are defective.

The ohmmeter must be accurate, and should be a scale type meter with 1½ or 3 volt cell. Most digital ohmmeters cannot be used to check semiconductors; however, some digital ohmmeters are specially designed to test semiconductors and can be used to test components in the regulator. Consult the ohmmeter manufacturer concerning the meter capabilities.

It is important that all of the following checks be made. If a defective part is found, replace it before proceeding with the remaining checks. Be sure to make all the checks as more than one component may be defective.

A defective part may be replaced by removing the attaching screws and unsoldering the connections. When resoldering, limit solder time to a minimum as excessive heat may damage the printed circuit and component parts. However, firmly soldered connections are essential for satisfactory operation. A resin core 63% tin, 37% lead solder with 360°F. melting point is recommended along with a soldering iron rated at 50 watts or less. Use extreme care to avoid overheating.

Before checking the circuit board, remove transistor TR1, which must be checked separately. Connect the ohmmeter as shown in figure 7-31 and then reverse the ohmmeter leads to obtain two readings on the same component. Use the middle scale on scale-type meters; the 300 ohm value should be within, or nearly within, the middle third of the scale. Refer to figure 7-31 for the following checks:

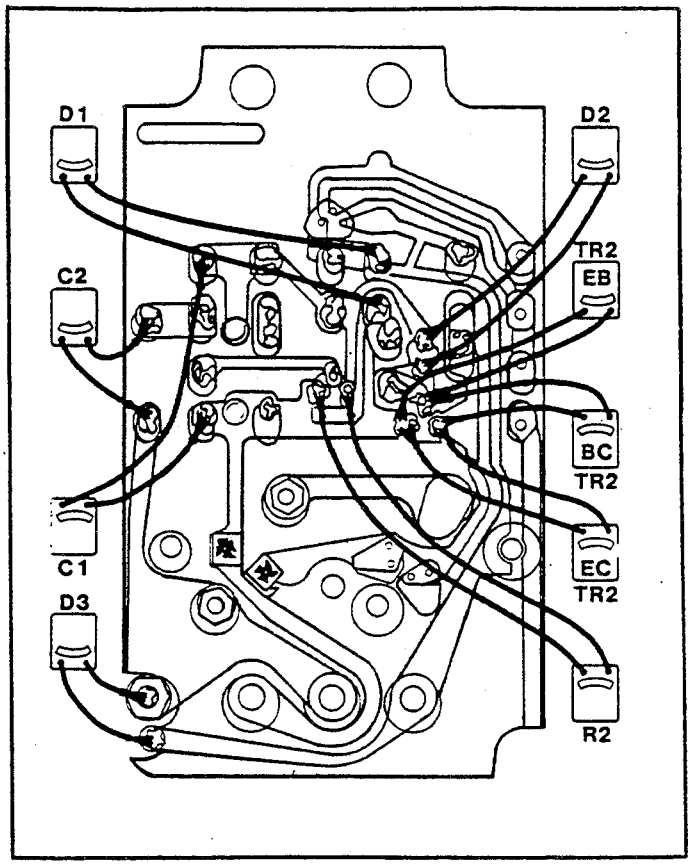


Figure 7-31. Checking Regulator Componets With Ohmmeter.

Capacitors C1 and C2 — The ohmmeter should read high and low on each capacitor. If not, replace capacitor.

Diodes D1, D2 and D3 — Each diode should give one high and one low reading. If not, replace diode.

Resistor R2 — Turn voltage adjustment screw with ohmmeter connected each way. Reading should change as slotted screw is turned. If not, replace R2.

Transistor TR2 — Change the ohmmeter to use the low scale. Check EB; should read low and high. Check BC; should read low and high. Check EC; should both read high. If not, replace TR2.

Transistor TR1 — See figure 7-32. Use the low scale. Each of the three checks should read low and high. If not, replace TR1.

MC-9 MAINTENANCE MANUAL

ADJUSTING VOLTAGE

After repair, the regulator must be adjusted to the desired voltage setting. Follow the procedure under previous section entitled Voltage Regulator Setting. Turn the adjusting screw full range and observe the voltmeter to ensure that the voltage is being controlled, then adjust to the setting desired or the setting listed in Delco Remy Bulletin 1R-188.

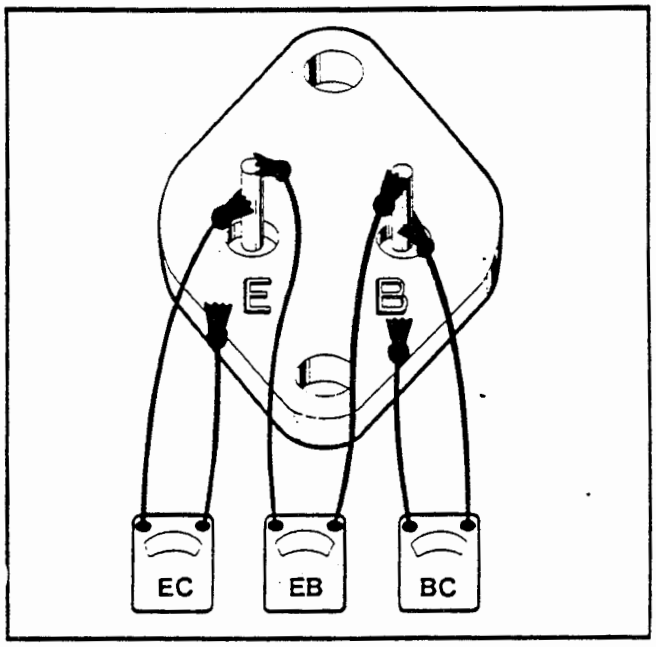


Figure 7-32. Ohmmeter Check of TR1.

STARTING MOTOR

The starting motor has a shift lever and solenoid plunger that is totally enclosed to protect it from exposure to dirt, icing conditions and splash. The commutator end cap can be removed to inspect the brushes. Refer to figures 7-33, 7-34 and 7-35.

Lubrication is provided in the sintered bronze bushings by an oil saturated wick. Oil can be added to each wick by removing an oil reservoir cup which is accessible on the outside of the motor.

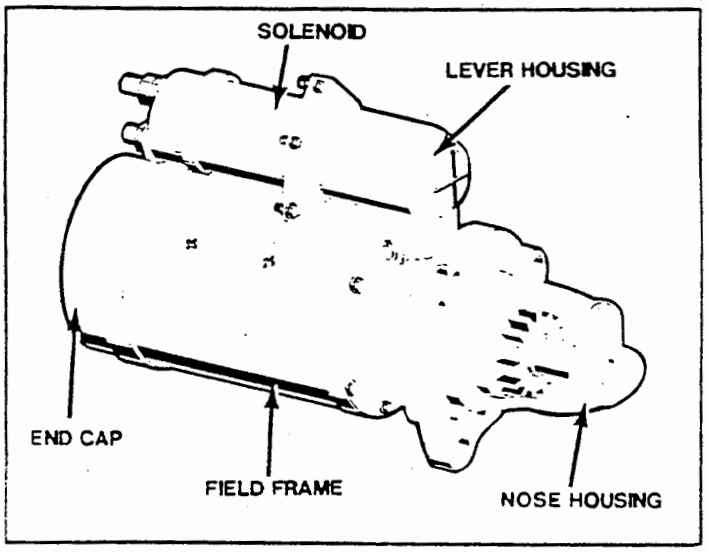


Figure 7-33. Starting Motor.

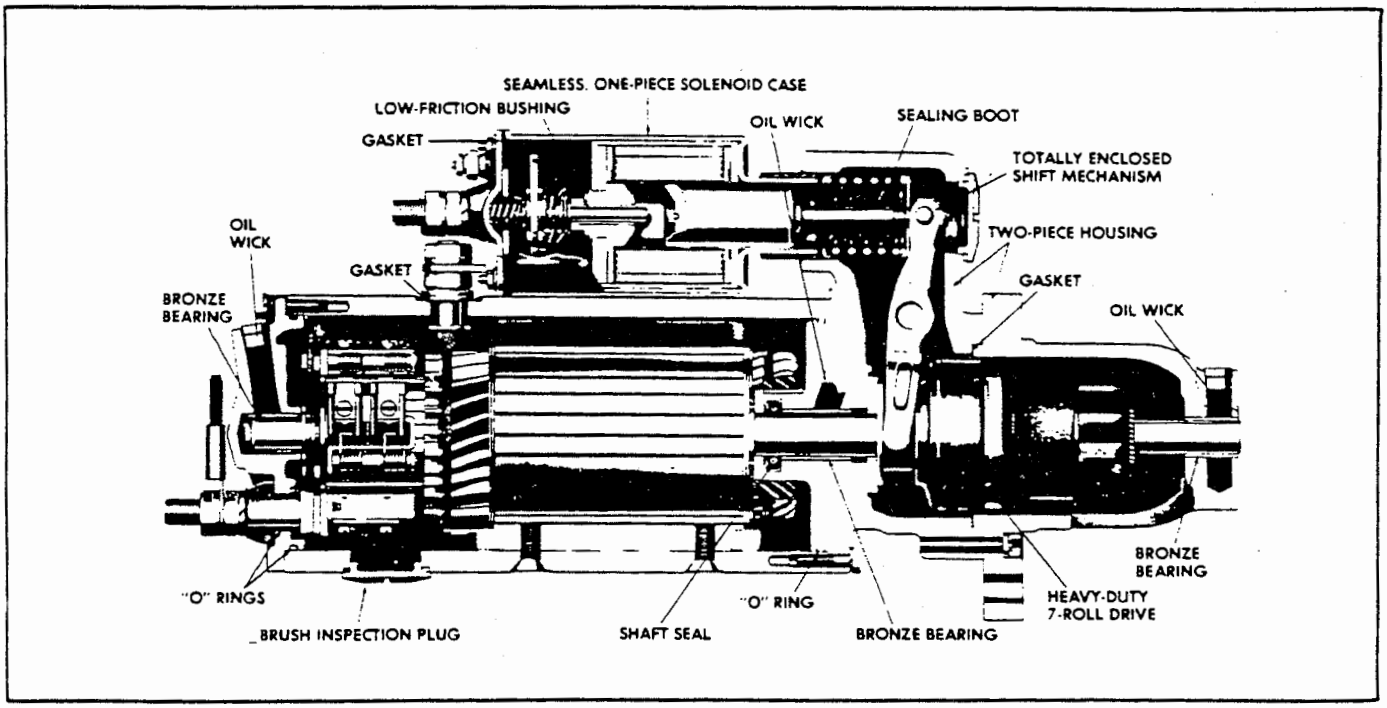


Figure 7-34. 40-MT Starting Motor Cross Section (to Dec. 1985); Also Typical 50-MT.

MC-9 MAINTENANCE MANUAL

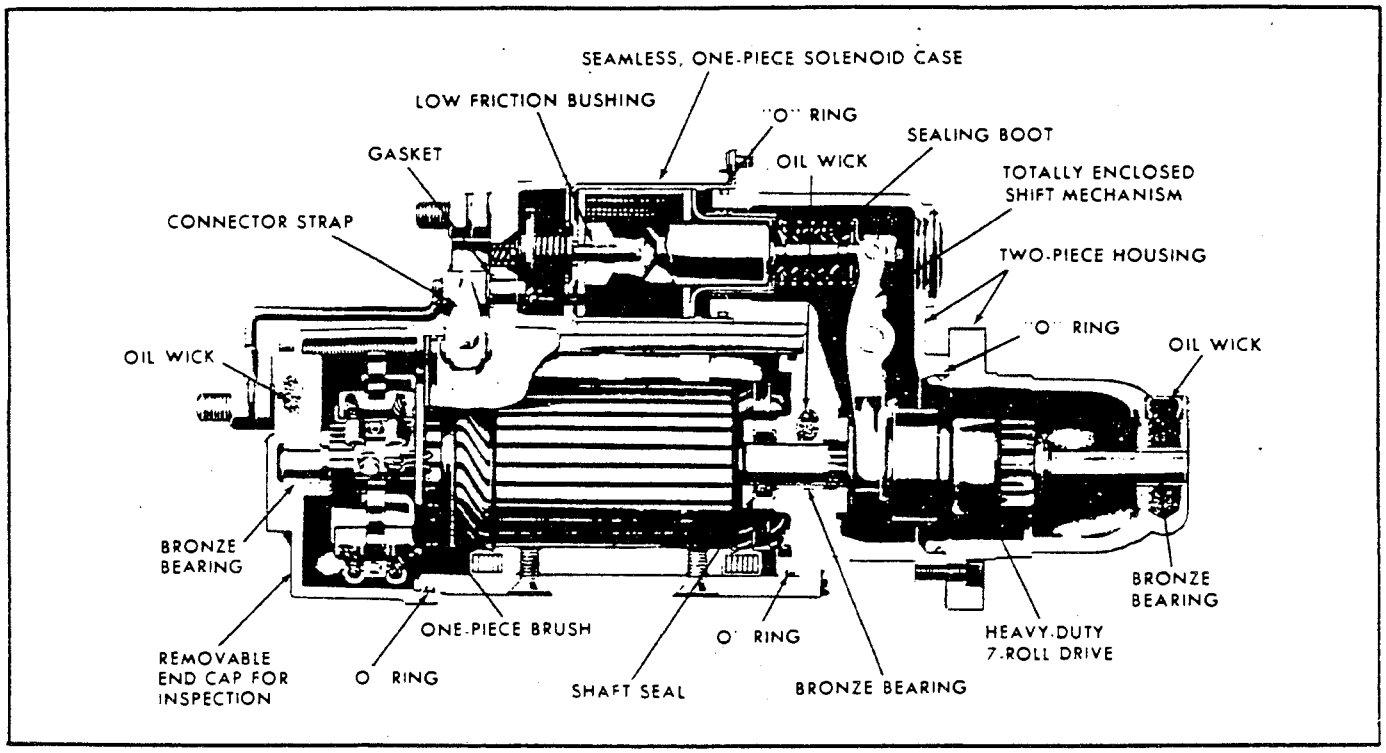


Figure 7-35. 42-MT Starting Motor Cross Section (after Dec. 1985).

The pinion is moved into mesh with the ring gear by the action of the solenoid. The pinion remains engaged until the solenoid circuit is interrupted. In case of a butt engagement the motor will not be energized to prevent damage to the pinion and gear teeth.

Under normal operating conditions, no maintenance will be required between engine overhaul periods. At time of engine overhaul, motors should be disassembled, inspected, cleaned and tested as described in succeeding paragraphs.

A basic circuit is shown in figure 7-36. When the start switch is closed, the magnetic switch contacts close, and the solenoid windings are connected to the battery. The resulting plunger and shift lever movement causes the pinion to engage the engine flywheel ring gear and the solenoid main contacts to close, and cranking takes place.

When the engine starts, pinion overrun protects the armature from excessive speed until the switch is opened, at which time the return spring causes the pinion to disengage. To prevent excessive overrun and damage to the drive and armature windings, the switch must be opened immediately when the engine starts. A cranking period for all types of motors should never exceed 30 seconds without stopping to allow the motor to cool.

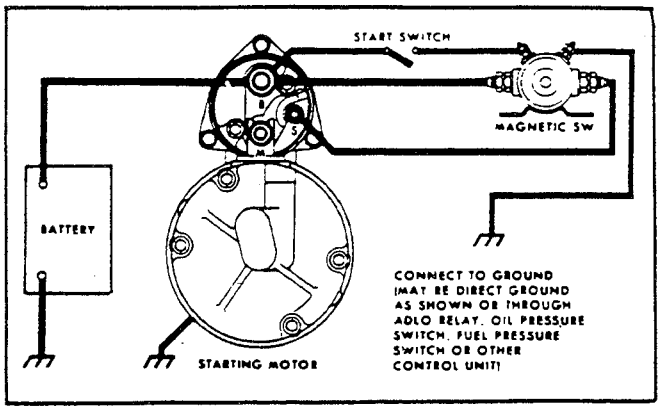

START SWITCH
MAGNETIC SW
BATTERY
CONNECT TO GROUND (MAT BE DIRECT GROUND AS SHOWN OR THROUGH ADLO RELAY, OIL PRESSURE SWITCH, FUEL PRESSURE SWITCH OR OTHER CONTROL UNIT)
STARTING MOTOR

Figure 7-36. Basic Starting Circuit.

Either of two types of starter protection may be present on the MCI Series of coaches. Later production (1987) coaches have the 3N124 Triple Protection Device as standard equipment. The optional Thermal Time Delay Relay may have been installed in lieu of the basic device. Earlier coaches may also have either of these devices, which would have been installed as optional or special equipment.

One of the functions of the Tripple Function Protective Device is to prevent starter re-engagement after the engine is running. Further information on this device can be found later in this section.

The optional Thermal Time Delay Relay prevents starter overheating by limiting the time the starter can be cranked without pause. It differs from the standard protection device in that it does not sense overvoltage to protect electrical components, nor does it prevent starter re-engagement when the engine is running.

The Thermal Time Delay Relay provides a 20-second timed start period followed by a 20-27-second reset delay to allow the starter to cool. Refer to the Thermal Time Delay wiring diagram later in this section.

TROUBLESHOOTING THE CRANKING CIRCUIT

If the cranking system is not performing properly, make the following checks to help determine which part of the circuit is at fault. Insure that the battery is fully charged. The wiring, switches and starting motor cannot be checked if the battery is defective or discharged.

1. Inspect the wiring for damage. Inspect all connections to the starting motor, solenoid, magnetic switch, ignition switch or

any other control switch, and battery, including all ground connections.

2. Clean and tighten all connections as required.

3. Inspect all switches to determine their condition. From the vehicle wiring diagram, determine which circuits should be energized with the starting switches closed. Use a voltmeter to detect any open circuits.

4. If the battery, wiring and switches are in satisfactory condition, and the engine is known to be functioning properly, remove the motor and follow the test procedures outlined below.

5 With the starting motor removed from the engine, the armature should be checked for freedom of rotation by prying the pinion with a screwdriver. Tight bearings, a bent armature shaft or a loose pole shoe screw will cause the armature to not turn freely.

6 If the armature does not turn freely, the motor should be disassembled immediately. However, if the armature does rotate freely, the motor should be given a no-load test before disassembly.

The no-load test may point to specific defects which can be verified with tests when disassembled. Also, the no-load test can identify open or shorted fields, which are difficult to check when disassembled. The no-load test also can be used to indicate normal operation on a repaired motor before installation.

NO LOAD TEST

1. Connect a voltmeter from the motor terminal to the ground return terminal, and use an RPM indicator to measure armature speed. See figure 7-37.

2. Connect the motor and an ammeter in series with a fully charged battery of the specified voltage, and a switch in the open position from the solenoid battery terminal to the solenoid switch terminal.

3 Close the switch and compare the RPM, current, and voltage reading with the specifications in the following table

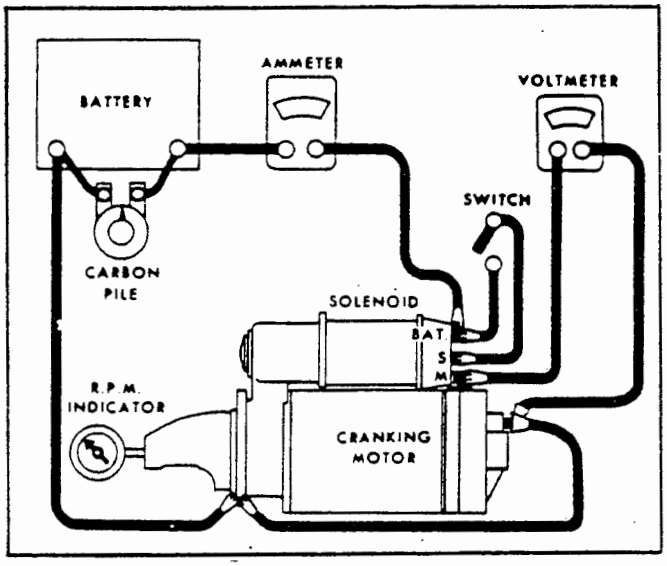


Figure 7-37. No-Load Test Setup.

NO LOAD STARTER TEST SPECIFICATIONS

Starter	Test Voltage	Min. Current Draw (Amps)	Max. Current Draw (Amps)	Min. RPM	Max. RPM
40MT (7G-1-1)	20	70	110	5500	9000
42MT (7G-1-39)	20	60	75	6500	7700
50MT (7G-1-38)	20	95	120	5500	7500

It is not necessary to obtain the exact voltage specified in the chart, as an accurate interpretation can be made by recognizing that if the voltage is slightly higher the RPM will be proportionately higher, with the current remaining essentially unchanged. However, if the exact voltage is desired a carbon pile connected across the battery can be used to reduce the voltage to the specified value

If more than one 12-volt battery is used, connect the carbon pile to only one of the 12-volt batteries. Make disconnections only with the switch open Interpret the test results as follows:

NOTE: Rated current draw and no-load speed indicates normal condition of the starting motor.

4 Low free speed and high current draw indicate.

a. Too much friction — tight, dirty, worn bearings, bent armature shaft or loose pole shoes allowing armature to drag.

b. Shorted armature. This can be further checked on a growler after disassembly.

c. Grounded armature or fields. Check further after disassembly.

5. Failure to operate with high current draw indicates:

a. A direct ground in the terminal or fields.

b. "Frozen" bearings (this should have been determined by turning the armature by hand).

6. Failure to operate with no current draw indicates:

a. Open field circuit This can be checked after disassembly by inspecting terminal connections and tracing circuit with a test lamp.

b Open armature coils. Inspect the commutator for badly burned bars after disassembly.

c Broken brush springs, worn brushes high insulation between the commutator bars or other causes which would prevent good contact between the brushes and commutator

7 Low no-load speed and low current draw indicate high internal resistance due to poor connections, defective leads, dirty commutator and causes listed in Number 6.

8 High free speed and high current draw indicate shorted field If shorted fields are suspected, replace the field coil assembly and check for improved performance

LUBRICATION

1 All bearings, wicks and oil reservoirs should be saturated with SAE No. 20 oil.

2 Place a light coat of lubricant Delco Remy No. 1960954 on the washer located on the shaft between the armature and shift lever housing.

NOTE: Sintered bronze bearings used in these motors have a dull finish, as compared to the early type machined, cast bronze bearings which had a shiny finish.

3. Before pressing the bearing into place, dip it in SAE No. 20 oil. Also, tangent wicks should be soaked with SAE No. 20 oil. Insert the wick into place first, and then press in the bearing.

CAUTION: Do not drill, ream or machine sintered bearings in any way! These bearings are supplied to size.

It is not necessary to cross-drill a sintered bearing when used with a tangent wick. Because the bearing is so highly porous, oil from the wick touching the outside bearing surface will bleed through and lubricate the shaft.

Middle bearings are support bearings and prevent armature deflection during cranking. As compared to end frame bearings, the clearance between middle bearing and shaft is large and the clearance provides a loose fit when assembled.

DISASSEMBLY AND REPAIR

Normally the starting motor should be disassembled only as necessary to make repair or replacement of the defective parts.

1. Matchmark the relative position of the solenoid, lever housing, and nose housing so the motor can be reassembled in the same manner.

2. Disconnect field coil from solenoid motor terminal and ground return lead from solenoid if present.

3. Remove the attaching bolts and separate the commutator end frame from the field frame.

4. Remove attaching screws to separate brush plate assembly from field frame.

5. Separate the nose housing and field frame from lever housing by removing attaching bolts.

6. Remove pinion stop.

7. Remove armature and clutch assembly from lever housing.

8. Separate solenoid from lever housing by pulling apart.

The drive, armature and fields should not be cleaned in any degresing tank, or with grease-dissolving solvents, since these would dissolve the lubricants in the drive and damage the insulation in the armature and field coils. All parts except the drive should be cleaned with mineral spirits and a brush. The drive can be wiped with a clean cloth.

If the commutator is dirty, it may be cleaned with No. 00 sandpaper.

CAUTION: Never use emery cloth to clean the commutator.

9. Inspect the brushes for wear. If they are worn excessively when compared with a new brush, they should be replaced. Make sure the brush holders are clean and the brushes are not binding in the holders. The full brush surface should ride on the commutator to give proper performance. Check by hand to insure that the brush springs are giving firm contact between the brushes and commutator. If the springs are distorted or discolored, they should be replaced.

10 If the armature commutator is worn, dirty, out of round, or has high insulation, the armature should be put in a lathe so the commutator can be turned. As a final step in this procedure, the commutator should be sanded lightly with No. 00 sandpaper.

NOTE: The undercut operation must be omitted on starting motors having Test Specification 7104 and 7113 as listed in Delco Remy Service Bulletin 1M-188. Do not undercut commutators on motors having this specification.

The armature should be checked for opens, short circuits and grounds as follows:

11 Opens — Inspect the points where the conductors are joined to the commutator bars for loose connections. Poor connections cause arcing and burning of the commutator bars as the cranking motor is used. If the bars are not too badly burned, repair can often be effected by welding the leads in the riser bars (using rosin flux), and turning the commutator in a lathe to remove the burned material.

12 Short Circuits -- Short circuits in the armature are located by use of a growler. When the armature is revolved in the growler with a steel strip such as a hacksaw blade held above it, the blade will vibrate above the area of the armature core in which the short circuit is located. Shorts between bars are sometimes produced by brush dust or copper between the bars These shorts can be eliminated by cleaning out the slots

13. Grounds — Grounds in the armature can be detected by the use of a 110-volt test lamp and test points. If the lamp lights when one test point is placed on the commutator with the other point on the core or shaft, the armature is grounded. Grounds occur as a result of insulation failure which is often brought about by overheating of the starting motor produced by excessively long cranking periods or by accumulation of brush dust between the commutator bars and the steel commutator ring.

FIELD COIL CHECKS — The various types of circuits used are shown in the wiring diagrams of Figure 7-38. The field coils can be checked for grounds and opens by using a test lamp.

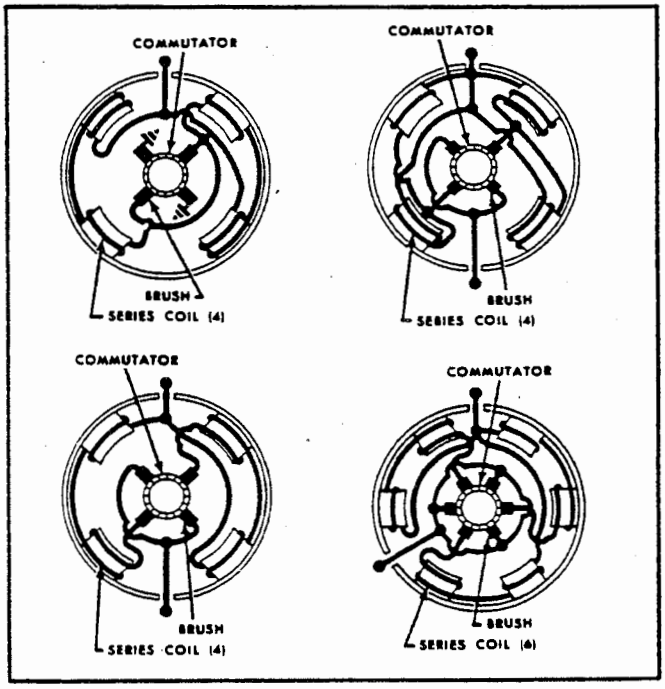


Figure 7-38. Typical Starting Motor Circuits.

MC-9 MAINTENANCE MANUAL

14 Grounds — If the motor has one or more coils normally connected to ground, disconnect the ground connections during this check. Connect one lead of the 110-volt test lamp to the field frame and the other lead to the field connector. If the lamp lights, at least one field coil is grounded which must be repaired or replaced. This check cannot be made if the ground connection cannot be disconnected.

15. Opens — Connect test lamp leads to ends of field coils. If lamp does not light, the field coils are open.

Field coils can be removed from the field frame assembly by using a pole shoe screwdriver. A pole shoe spreader may also be used to prevent distortion of the field frame. Careful installation of the field coils is necessary to prevent shorting or grounding of the field coils as the pole shoes are tightened into place.

Where the pole shoe has a long lip on one side and a short lip on the other, the long lip should be assembled in the direction of armature rotation so it becomes the trailing (not leading) edge of the pole shoe.

SOLENOID CHECKS — A basic three-terminal solenoid circuit is shown in A of Figure 7-39, and a four-terminal solenoid circuit is shown in B. With all other leads disconnected, the solenoid windings can be checked by making test connections as covered below.

THREE-TERMINAL SOLENOID:

CAUTION: To avoid excessive heating, in the following tests, leave the pull-in winding connected no more than 10 seconds at a time. The current will decrease as the heating increases.

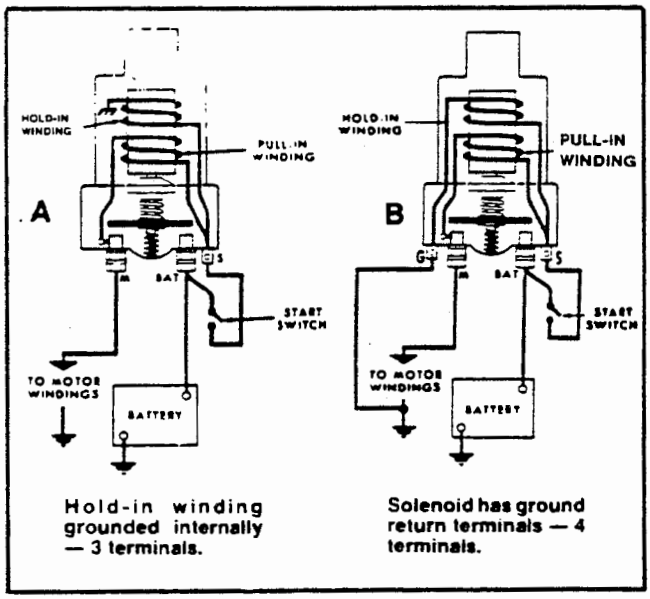


Figure 7-39. Solenoid Circuits.

16 As shown in figure 7-40, make connections to the "S" terminal and a clean metal ground. If needed, use the carbon pile to decrease the battery voltage to the value specified in the following table and compare the ammeter reading with the hold-in winding specifications. A high reading indicates a defective winding (shorted or grounded hold-in or a grounded pull-in), and a low reading indicates excessive resistance.

SOLENOID TEST SPECIFICATIONS

	Pull-In Windows		Hold-In Windows	
Solenoid	Test Voltage	Current Draw	Test Voltage	Current Draw
7G-1-84*	5	85-100	20	110-150
7G-6-25**	5	9.0 11 5	20	68 Max

* Used With 42MT Starter (7G-1-39)
** Used With 40MT Starter (7G-1-1) and 50MT (7G-1-38)

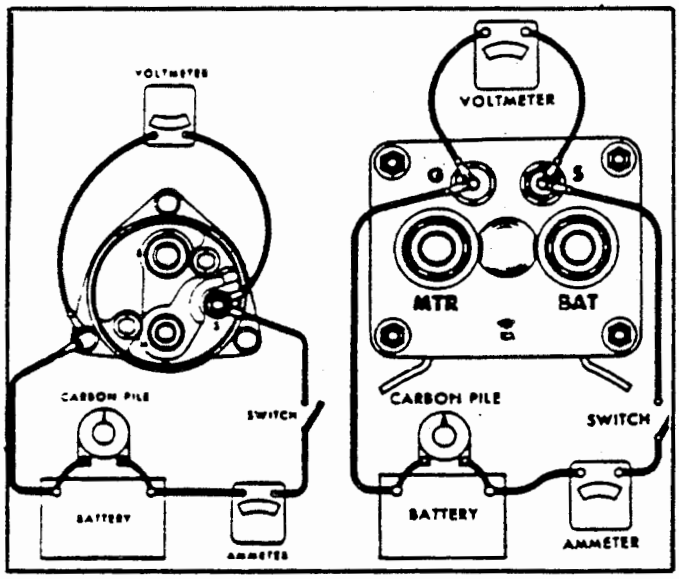


Figure 7-40. Checking Solenoid Hold-In Winding.

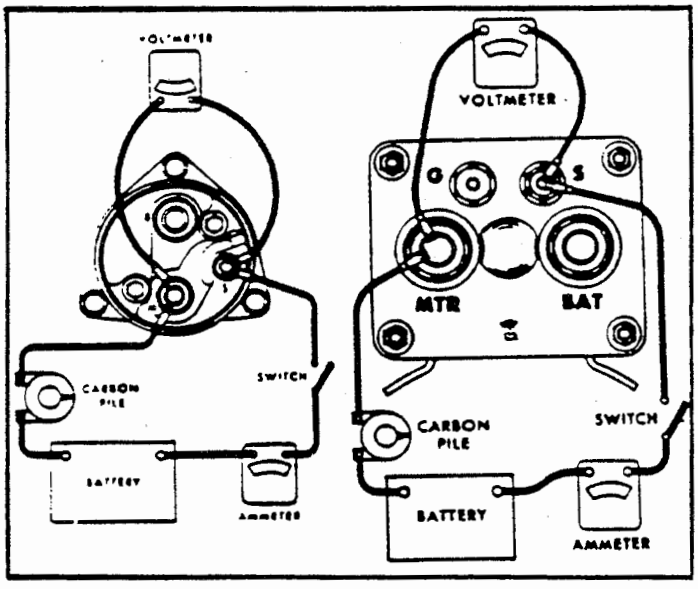


Figure 7-41. Testing Pull-In Winding On Solenoid.

17 To check the pull-in winding connect from the solenoid switch terminal to the solenoid motor terminal (figure 7-41). Compare with the pull-in winding specification. A high reading indicates a shorted pull-in winding, and a low reading indicates excessive resistance.

FOUR-TERMINAL SOLENOID:

18. As shown in figure 7-42, make connections to the "S" and ground return terminals. If needed, use the carbon pile to decrease the battery voltage to the value specified and compare the ammeter reading with the hold-in winding specifications. A high reading indicates a shorted winding, and a low reading indicates excessive resistance.

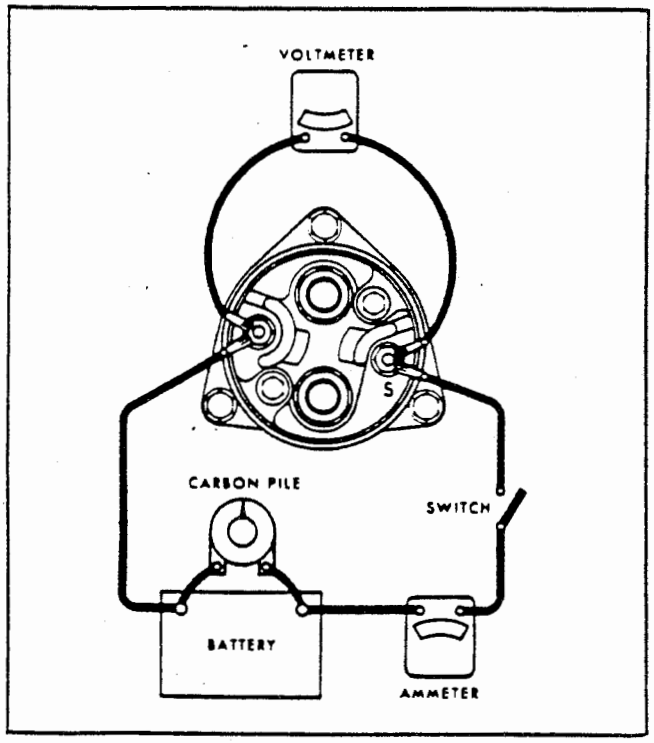


Figure 7-42.

19. To check the pull-in winding connect from the solenoid switch terminal to the solenoid motor terminal. Compare with the pull-in winding specification. A high reading indicates a shorted pull-in winding, and a low reading indicates excessive resistance.

CAUTION: To avoid excessive heating, leave the pull-in winding connected no more than 10 seconds at a time. The current will decrease as the heating increases.

20. To check for grounds, move battery lead from "M" terminal (figure 7-41) to a clean metal ground on the solenoid case (not shown). Ammeter should read zero. If not, hold-in or pull-in winding is grounded.

NOTE: To reduce the voltage to the specified value, connect the carbon pile between the battery and the "M" terminal as shown.

21. The magnetic switch can be checked in the same manner by connecting across its winding.

REASSEMBLY

1. To reassemble the brush plate assembly with brushes on the field frame with armature in place, lift the brushes up so the spring contacts the side of the brush.
2. Assemble to the field frame with the attaching screws.
3. Lift up springs, and position brushes onto commutator.

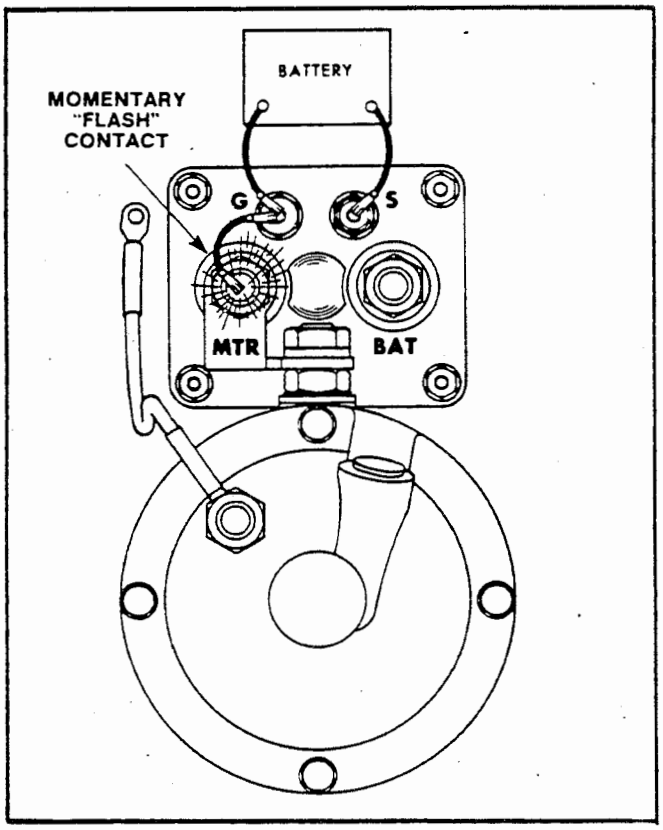


Figure 7-43. Connections for Checking Pinion Clearance (40MT & 50MT).

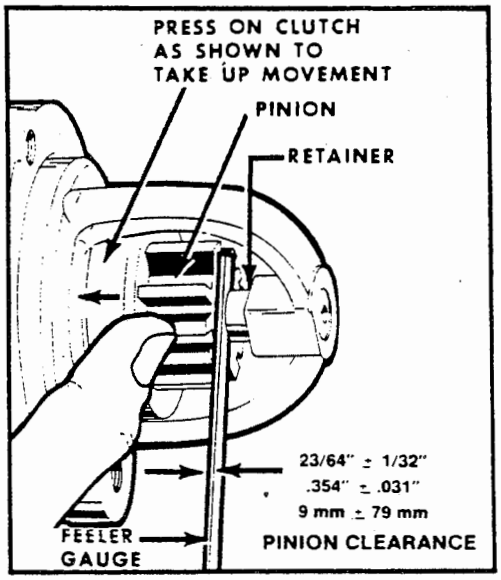


Figure 7-44. Checking Pinion Clearance (40MT & 50MT).

PINION CLEARANCE (40 MT)

To check pinion or drive clearance follow the steps listed below

1 Make connections as shown in figure 7-43.

2. Momentarily flash a jumper lead from terminal G to terminal MTR. The drive will now shift into cranking position and remain so until the battery is disconnected.

3 Push the pinion or drive back toward the commutator end to eliminate slack movement.

4 Measure the distance between drive and housing (figure 7-44).

6 Adjust clearance by removing plug and turning shaft nut (shown in figure 7-46) Although typical specifications are shown, always refer to 1M-188 for specifications applying to specific models.

PINION CLEARANCE (42MT)

To check pinion or drive clearance follow the steps listed below.

1 Make connections as shown in figure 7-45.

2 Momentarily flash a jumper lead from ground return terminal to terminal MTR (figure 7-45). The drive will now shift into cranking position and remain so until the battery is disconnected.

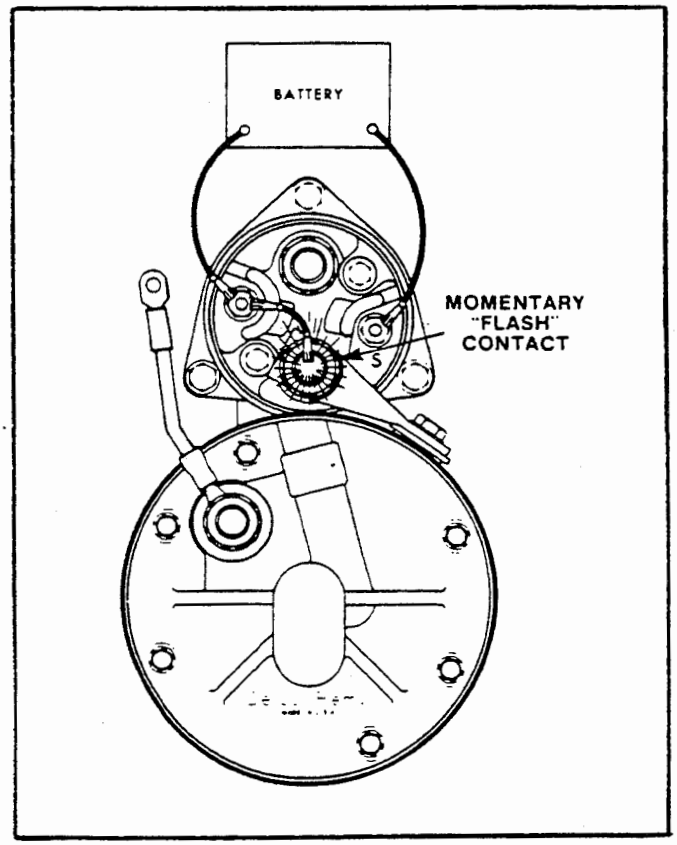


Figure 7-45. Connections for Checking Pinion Clearance (42-MT).

3. Push the pinion or drive back toward the commutator end to eliminate slack movement.

4. Measure the distance between drive and housing (figure 7-46).

5. Adjust clearance by removing plug and turning shaft nut (figure 7-46). Although typical specifications are shown, always refer to 1M-188 for specifications applying to specific models.

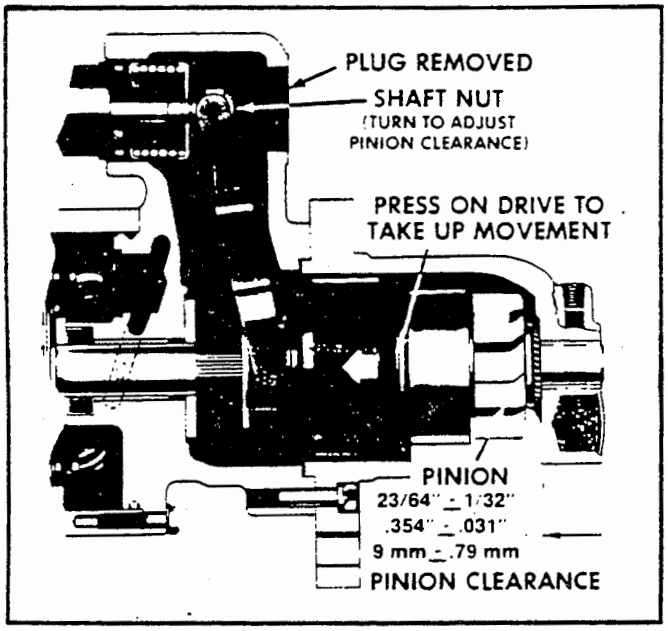


Figure 7-46. Checking Pinion Clearance (42MT).

BATTERIES

DESCRIPTION

Two 12-Volt batteries are connected in series, mounted in a compartment behind the fuel tank compartment door on the right hand front side. Battery cells may be checked and filled at this point.

IMPORTANT: Observe decal on inside of battery compartment for proper connections.

The battery has four (4) major functions to perform on the coach.

(1) It provides a source of current for starting the engine.

(2) It acts as a stabilizer to the voltage in the electrical system.

(3) It can, for a limited time, furnish current when electrical demands of the electrical equipment exceed the output of the generator.

(4) It provides a limited source of power for connected accessories, when the engine is not running.

In replacing batteries, only batteries of the same specification should be used. Refer to "Specifications" at the end of this section.

The electrical system is negative ground, with the negative battery terminal connected to the coach frame.

MC-9 MAINTENANCE MANUAL

CAUTION: Make certain that connections are not reversed, since damage to electrical system components will result.

IMPORTANT: After battery cables have been disconnected, wrap terminal with electrical tape or equivalent to prevent accidental grounding.

Electrolyte level in the battery should be checked at least every 1,000 miles (1,600 km) or every week. If the electrolyte level is found to be low, water should be added to each cell until the level rises to the bottom of the vent well.

NOTE: Do not overfill cells.

Level of electrolyte can be checked by the use of a flashlight and mirror. Hold mirror over each cell opening and direct flashlight beam so level can be seen.

Distilled water should be used to eliminate the possibility of impurities being added to the electrolyte.

NOTE: Do not add any substance to the electrolyte except water.

The freezing point of the electrolyte depends upon its specific gravity. The following table gives freezing temperatures of various specific gravities.

SPECIFIC GRAVITY	°F FREEZING TEMP.	°C
1.100	+18	-8
1.120	+14	-10
1.140	+8	-13
1.160	+2	-27
1.180	-6	-21
1.200	-17	-17
1.220	-31	-35
1.240	-51	-46

(1) Check voltage drop between grounded battery terminal (negative) and vehicle frame. With the starting motor turning over, the voltage reading should be less than 0.3 volts. If more, there is excessive resistance in circuit.

(2) Check voltage drop between positive terminal of battery and starting motor terminal stud while starting motor is operating. If the reading is more than 1.0 volts, the resistance is excessive.

(3) Check voltage drop between the starting motor housing and the bus frame. If over 0.2 volts, the resistance is excessive.

CLEANING AND INSPECTION

The external condition of the battery and the battery cables sould be checked periodically. The top of the battery should be kept clean and the battery hold-down bolts should be kept properly tightened. Neutralize all acid with soda and water solution. Flush trays and battery compartment thoroughly with water. Care must be taken to keep vent plugs tight so that the neutralizing solution does not enter the cells. Repair damage done by acid as required. Scrape all paint bubbles to bare metal. After drying, repaint interior of the battery compartment and the trays with No. 701 Red-Con-Treat Paint. Be sure to check all grommets and cable hangers for possible damage to cables. The hold-down bolts should be kept tight enough to prevent the battery from shaking in its holder, but should not be tightened excessively as to place strain on the battery case.

To ensure a proper contact, the battery cable clamps should be tight on the battery posts. If the posts or cable clamps are corroded, the cables should be disconnected and the posts and clamps cleaned separately with soda solution and a wire brush. A coating of petroleum jelly should then be applied to the battery posts and the inside of cable clamps to prevent oxidation. Corrosion at the posts can be avoided by lightly coating the posts and the cable clamps with petroleum jelly and by placing oil soaked felt washers on terminal posts under clamps.

BATTERY TESTS

Place a load on batteries with starter for 30 seconds and turn on headlights — low beam — 20 amp. draw — and leave on while using an expanded scale volt meter of .01 scale divisions, check all cells for capacity. If all cells read 1.95 Volts or more with less than .05 volts difference between highest and lowest cell reading, battery is good and sufficiently charged.

NOTE: When replacing a battery both batteries must have an equal state of charge. The regulator is controlled by the counter voltage in the good battery, therefore the weak battery will never come up and eventually the good battery will fail.

CHECK SPECIFIC GRAVITY

Use a temperature-correcting hydrometer to measure the specific gravity of each cell.

If any cell has a specific gravity below 1.215 charge batteries as described below.

NOTE: If the electrolyte level in any cell is too low to produce a reading, add water to the battery and perform "Battery Charge" described later.

BATTERY CHARGE

If battery is under 1.230 specific gravity, it must be charged. If the specific gravity reading is less than .050 points between lowest and highest cell, recharge for 24 hours at 12 to 15 amps and 15 volts. Battery is fully charged when reading is checked for three (3) consecutive hourly checks, and no increase is noted.

If the reading of any cell fails to reach 1.250 @ 80°F or if a variation exists of more than 25 gravity points between cells after charging, replace the battery.

NOTE: Highly sulfated batteries may have to be charged at 16 or 17 volts to start charging current to flow through the battery, then reduce rate to regular charge of 15 volts. They may require up to 48 hours charging.

NOTE: Do not allow electrolyte temperature to go above 125°F (52°C).

HIGH RATE DISCHARGE TEST

Never check a battery in a discharge state. Specific gravity must be above 1.230 for the high rate discharge test. If battery was slow-charged, it should stand 8 to 10 hours between performing high rate discharge.

HOOK UP

The battery leads must be connected to the battery, red to positive, black to negative. Turn the voltmeter selector to the 16 volt position. Connect the voltmeter leads to the battery posts.

TEST PROCEDURE

Turn the load selector clockwise until the upper scale of the D.C. amperes meter reads two times the ampere-hour rating of the battery. Hold this load on for 15 seconds. While the load is on, read the battery terminal voltage on the 16 Volt scale of the D.C. Volts meter. Turn all controls to off and disconnect the tester.

NOTE: If the terminal voltage reads 10.6 or more the battery is good.

(1) Check voltage drop between grounded battery terminal (negative) and vehicle frame. With the starting motor turning over, the voltage reading should be less than 0.3 volts. If more, there is excessive resistance in circuit.

(2) Check voltage drop between positive terminal of battery and starting motor terminal stud while starting motor is operating. if the reading is more than 1.0 volts, the resistance is excessive.

(3) Check voltage drop between the starting motor housing and the bus frame. if over 0.2 volts, the resistance is excessive.

COMMON CAUSES OF BATTERY FAILURE

When a battery fails, the cause of failure may be outside the battery. For this reason, locate and correct the cause of the failure to prevent recurrence. Some common causes of battery failure are as follows:

(1) Defect in generating system such as high resistance or faulty generator or regulator.

(2) Defective starter or excessive use of accessories.

(3) Dirt and electrolyte on top of batteries.

(4) Hardened battery plates, due to battery being in a low state of charge over a long period of time.

(5) Shorted cells, loss of active material from plates.

(6) Driving conditions or requirements under which the vehicle is used only for short drives.

CAUTION: When making the above checks, make certain the engine does not start accidentally.

EQUIPMENT REQUIRED TO PERFORM ELECTRICAL SYSTEM CHECKS

(A) Salt brine load stack unit which includes the following items:

(1) Load stack electrode.

(2) 28-30 U.S. gallon (106-113 liters) plastic can.

(3) One (1) cart with casters. Cart size 30" high x 18" wide x 24" long (762 mm x 457 mm x 609 mm).

(4) One (1) 0 to 500A external shunted amp. meter to read generator output.

(5) One (1) 0-15A amp. meter to be wired in series with a 10A circuit breaker (reset type) and variable rheostat in field coil circuit.

(6) One (1) 200 Watt and 150 ohm variable rheostat.

(7) One (1) 10A circuit breaker (reset type).

(8) One (1) 0 to 30V Voltmeter.

(9) One (1) 50 M.A. external shunt, for 500A amp. meter.

(10) One (1) Model 10W-12 heath oscilloscope to be mounted on cart along side instrument board (at location desired only).

(11) Two (2) pairs 6" (152 mm) vice-grip pliers to make fast hookup to coach circuit.

(12) Two (2) 8 ft. (2.4 m) pcs. — Welding Cable for leads to load stack electrodes one end and vice grips on other end.

(B) **Note:** The following items are required in cart for checking and servicing batteries and starter.

(1) One (1) Columbia type AC-DC tong test amp. meter 0-800 amp. scale-plus 0-150 extra scale and carrying case. The tong tester is used to check current draw on engine starter as follows:

(a.) Clamp tongs around battery cable to the starter.

(b.) Spin engine over with starter with fuel rack in no fuel position to prevent engine from cranking. Operate 5 seconds and record reading. Should be winding 29.5 to 34.6 amps. approx. Hold in windings 4.5 to 6.0 amps.

(C) One (1) exide CA-200 battery tester-analyzer or an expanded scale volt meter of .01 scale divisions to perform the battery light load test. The CA-200 analyzer is recommended as it will test all type batteries by activating the meter with the electrolyte solution. Same procedure is followed.

CAUTION: Battery may be damaged if test probes contact plates.

(D) Wooden battery tool tray painted with creosote.

(E) One (1) battery hydrometer.

(F) Two (2) battery terminal and post cleaner.

(G) One (1) wire brush.

(H) One (1) box baking soda to clean battery and terminals.

(I) One (1) cup of chassis lube and a brush (small) to apply grease to post and terminals to prevent or retard corrosion.

(J) A supply of corrosion resisting felt washers to be placed over battery posts prior to cable terminal installation.

BOOSTER BATTERY STARTING

CAUTION: Any procedure other than the following could result in:

(1) Personal injury caused by electrolyte squirting out of the battery vents.

(2) Personal injury or property damage due to battery explosion.

(3) Damage to the charging system of the booster vehicle or of the immobilized vehicle.

DO NOT attempt to jump start a vehicle having a frozen battery because the battery may rupture or explode. If a frozen battery is suspected, examine all fill vents on the battery. If ice can be seen, or if the electrolyte fluid cannot be seen, do not attempt to start the vehicle with jumper cables as long as the battery remains frozen. Both the booster battery and the discharged battery must be treated carefully when using jumper cables. Follow EXACTLY the procedure outlined below, being careful not to cause sparks.

CONNECTING BOOSTER BATTERY AND JUMPER CABLES

(1) Set parking brake, turn off lights, heater and other loads. Remove 12 Volt leads at battery.

(2) Remove vent caps from both the booster and the discharged batteries. Lay a cloth over the open vent wells of each battery. These two actions help reduce the possibility of explosion which is always present when connecting a "live" booster battery to a "dead" battery.

(3) Attach one end of one jumper cable to the positive terminal of booster battery (identified by a red color "+" or "P" on the battery case, post or clamp), and the other end of the same cable to the positive terminal of the discharged battery. **DO NOT** permit vehicles to touch each other as this could establish a ground connection and counteract the benefits of this procedure.

(4) Attach one end of the remaining negative (—) cable to the negative terminal (black color "—" or "N") of the booster battery, and the other end to ground location on the vehicle being started. DO NOT CONNECT DIRECTLY TO NEGATIVE POST OF DEAD BATTERY — taking care that clamps from one cable do not inadvertently touch the clamps on the other cable. DO NOT lean over the battery when making this connection.

NOTE: The ground is to be at least 12 inches from the battery filler caps, and provide good electrical conductivity and good current carrying capacity.

DISCONNECTING BOOSTER BATTERY & JUMPER CABLES

(1) Taking care that clamps from one jumper cable do not inadvertently touch clamps on the other jumper cable, disconnect jumper lead from ground location on the vehicle being started. DO NOT lean over the battery when disconnecting this lead.

(2) Remove remaining end of negative (—) jumper cable from the booster battery.

(3) Remove one end of the remaining jumper cable from positive terminal of the discharged battery, then remove the other end of the same cable from positive terminal of the booster battery.

(4) Remove cloths from open vent wells of each battery. Discard cloths as they may have corrosive acid on them. Install vent caps on both the booster and the discharged battery.

OPTIONAL 12-VOLT POWER SOURCES

Either of two optional 12-volt power sources may be installed on the coach.

12-VOLT POWER SOURCE - 10-AMP LIMIT

This installation is made with 10-gauge wire and has a 10-amp circuit breaker. Twelve-volt electrical items with a combined current draw of less than 10 amps may be used with this system.

NOTE: Since this 12-volt power source draws only from the rear 12-volt battery, excessive use or heavy loading can result in premature battery failure. Periodic rotation of the batteries will help to extend battery life.

A cut-off relay is provided with this installation and cuts off all power to 12-volt items when the battery disconnect switch (figure 7-1) is shut off.

An installation and wiring layout diagram is included in the diagrams and schematics located in the later pages of this section.

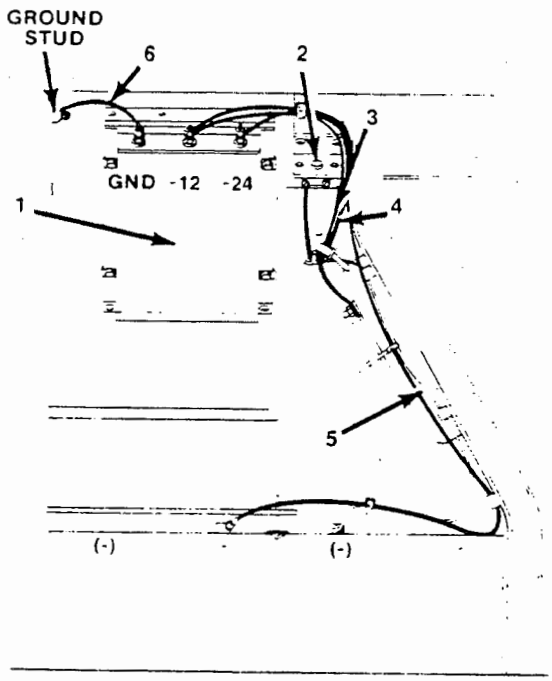
12-VOLT POWER SOURCE - 40-AMP LIMIT

Twelve-volt equipment with a combined current draw up to 40 amps can be used with this system. The main features of this system are a battery equalizer and a 40-amp circuit breaker (figure 7-47).

This system is installed on all coaches which have electronically controlled engines (DDEC) or electronically controlled transmissions (ATEC).

A schematic of this system will be found in the later pages of this section.

MC-9 MAINTENANCE MANUAL



1. Battery Equalizer
2. Circuit Breaker
3. Cable - - 12V Stud to Circuit Breaker
4. Cable - - 24V Stud to Main Disconnect
5. Cable - - 12V Stud to Positive Post On Rear Battery
6. Cable - Ground

Figure 7-47. Installation of Battery Equalizer and Circuit Breaker.

BATTERY CHARGE EQUALIZER

DESCRIPTION

The battery charge equalizer maintains the voltage balance and charge acceptance rate of each battery to anywhere from 0.1 to 0.01V under a light load and within 0.5V full load.

With this system, it is not necessary to replace both batteries if one of them becomes defective; the equalizer system will maintain a balance between the old and new battery.

NOTE: When replacing only one of the batteries, install the new battery in the grounded position (at the rear of the battery compartment.

OPERATION

When the voltage of the grounded battery is higher than that of the ungrounded battery (battery "B"), the equalizer is in a standby mode. When battery "A" decreases in voltage to just below that of battery "B" the equalizer turns on and transfers just enough power from "B" to "A" to satisfy the load and to maintain an equal voltage and charge in both batteries.

The following three operational conditions will normally be encountered; the equalizer will function as described.

1. A 24VDC load is present; no 12V load is present. The system will operate as a normal 24VDC system would, whether the alternator is on or not and the equalizer is in a standby mode. It will make minute adjustments to keep the batteries in balance.

2. Both 24- and 12-volt loads are present, and the alternator is off. Both batteries will discharge at the same rate even though there is an unequal load. (See opertion above.)

3. Both 12- and 24-volt loads are present and the alternator is on. The alternator will provide 24VDC just as though there were no equalizer or 12V load in the system. The equalizer transfers the 24V to 12V for the load, plus maintains battery balance.

SAFETY FEATURE

The +12-volt output of the equalizer is current limited making it short circuit proof and virtually indestructible. In the unlikely event of a failure of the unit, battery "A" will sustain the load for a limited length of time and you would have about the same condition as if you had a battery failure.

TESTING THE EQUALIZER

The following procedure provides a test to determine if the equalizer is working properly. The test equipment that will be required is one sealed beam 12V headlamp, and two jumper wires.

1. Disconnect the ground lead from the equalizer ground stud.

2. Connect one lead of the test seal beam headlamp to the 12V stud on the equalizer. Connect the other lead on the sealed beam headlamp to the ground stud on the equalizer.

3. If the equalizer is operating properly, the headlamp will glow steadily.

4. If a malfunction exists in the equalizer, the light will either glow steadily and then go out, or will not illuminate at all.

5. After test is complete, reconnect the battery ground lead to the equalizer ground stud.

3N124 TRIPLE FUNCTION PROTECTIVE DEVICE

This device is present on many of the MCI Series of coaches manufactured prior to 1987. It is standard equipment on these coaches beginning in 1987.

NOTE: This device is not present on coaches which have the optional Thermal Time Delay Relay.

All three functions are contained in a unit which is mounted in the rear junction box. Refer to the 3N1214 Triple Function Protective Device wiring diagram at the end of this section.

A description of each of the three functions follows.

1. **High Voltage Cutout Funtion —** One section of the Triple Function Protective Device uses a relay to interrupt power to the alternator field solenoid in the event of a high-voltage condition. The interrupt circuit is between the two blue wires coming out of the unit. The contact capabilities are 3 amps DC, which is more than adequate to run the field relay. The relay in the protective device is normally relaxed and the contacts are normally closed. In the event the voltage to the unit

exceeds 30 volts for a period of time in excess of 0.5 seconds, the relay will energize, thus opening the contacts and interrupting the alternator field relay. It has a self-holding feature so that the interruption will continue until the driver shuts off the master switch and turns it on again. If the high-voltage condition still exists, the unit will trip again. The driver will be aware of the fact because the alternator discharge light will be turned on at the driver's instrument panel and in the engine compartment. The 0.5-second time delay will eliminate false tripping because of momentary transients caused by turn signals, air conditioners, or other circuit interruptions. Under normal circumstances this relay will never be energized; therefore, it draws no power from the coach supply system until an overload condition occurs. If the alternator discharge light should come on, it would indicate a malfunction in the electrical system which should be corrected by maintenance personnel. The driver should be advised, however, to cycle the master switch in an attempt to cure the difficulties in case the high-voltage condition was only momentary. The 0.5-second time delay provides protection from transients, but will still save light bulbs, electric motors and dashboard instruments from failures due to a high-voltage condition.

2. **Low Oil Pressure Switch Interrupt Function —** The function of this element is to prevent the low oil pressure switch from shutting down the engine before oil pressure can be established immediately after engine start-up. The interrupt contacts have 3-amp capabilities and are in the black wires coming out of the unit. These wires should interrupt the low oil pressure switch circuit and are connected in series with that switch. Internally the relay that controls this interrupt is normally unenergized and the contacts are normally closed. When the starter is energized, so also is the interrupt relay, thus opening the low oil pressure switch line. The relay remains energized (and thus the contacts open) for the duration of the cranking cycle **and** for 10 seconds thereafter. The relay in this element is energized only during the cranking cycle and for 10 seconds thereafter, at which time it returns to the relaxed or unenergized state. The only time it draws power, therefore, is during the cranking cycle and for 10 seconds thereafter. Starting a new cranking cycle (initiated prior to the time that the 10-second period from the first cranking cycle has expired), the time delay will be rearmed and a new 10-second cycle will begin at the conclusion of the cranking period.

3. **Starter Protector Function —** The function of this portion of the device is to prevent the starter from being activated if the engine is turning. This element uses the R-1 lead output of the alternator to sense engine movement. If the engine is turning, no matter how slowly, it will prevent the starter from being engaged; however, it will still allow the override features of the starter switch to function. It does not interrupt the override for high engine temperatures or low oil pressure. Neither will it interrupt the starter cycle as soon as the engine begins to crank. The instant the driver releases the starter switch after cranking, the starter is prevented from being re-engaged until the engine comes to a complete halt. This is accomplished by a relay with contact capabilities of 3 amps. This relay remains unenergized until such time as the master switch is turned on. At that time the relay is energized, thus allowing the starter switch to supply power to the starter solenoid relay. It remains energized and thus the starter circuit completed until such time that the driver energizes the starter switch and throughout the cranking cycle. When the starter button is released **and** the engine is turning, the relay de-energizes (thus interrupting the starter solenoid circuit) and remains in this condition as long as the engine is turning, no matter how fast or how slowly. Thus the starter mechanism is prevented from being engaged until the engine comes to a complete stop. Again, under normal operating conditions, the circuit draws no power from the coach, except momentarily between the time the master switch is energized and the engine is started.

While the engine is running should the starter switch be engaged, it will serve to override the high temperature or low oil pressure contacts but will not allow the starter solenoid relay to be activated.

The starter protector element of the 3N124 device is connected to a warning light on the driver's instrument panel. This light, when illuminated, tells the driver that the starter solenoid relay is armed. Under normal operating conditions, the light comes on when the master switch is turned on and will remain on until engine start-up has been accomplished.

Should the warning light remain illuminated after the engine has started, or if it comes on during coach operation, the driver is warned of a fault in the system and that the starter solenoid relay is armed. A broken R-1 lead or a faulty relay would cause the light to come on. Either of these malfunctions would prevent a signal being sent to the starter protection element that the engine is turning over. Under certain operating conditions, such as attempting to crest a long grade without engine shutdown, the driver might press the starter switch. Before pressing the starter switch the driver should be certain that the warning light is not illuminated. **He must not use the override feature of the starter switch if the warning light is on.** If he does so and the engine is turning over, serious damage to the starter or engine flywheel can result.

TESTING OF 3N124 TRIPLE FUNCTION PROTECTIVE DEVICE

To test the Triple Function Protective Device after it is installed in the coach, proceed as follows:

1. With the battery disconnect switch in the "ON" position, turn the master switch "ON" at the driver's instrument panel, the "Starter Alert" telltale light at the dash should be lit. This indicates the starter is armed and ready.

2. To test the starter protection feature, start the engine and DO NOT release starter switch (or keyed ignition switch). The starter should "drop out" almost immediately following engine start-up and the telltale light should go out.

3. With the engine at idle, release the starter switch and attempt to re-engage the starter. There should not be any response.

4. Ground the left-hand "Hot Engine" alarmstat and hold the starter switch prior to engine shutdown. The engine should continue to run without starter engagement as long as the starter switch is held in the "ON" position (starter bypass feature).

> **CAUTION: If the telltale light remains on following engine start-up, release the starter switch (or keyed ignition switch) immediately and DO NOT perform step 3. (No Starter Protection)**

5. To test the Low Oil Pressure Switch interrupt feature, ground circuit #60 at the 3-lb. oil sender while the engine is running. The engine will shut down following approximately a 10-second delay.

6. To test the Overvoltage Protection Feature, place a volt ohmmeter between "A1" and ground at the regulator (50VDC scale).

7. With the engine running at fast idle (no load), SLOWLY move the adjustment screw at the regulator clockwise and observe the voltage reading. The alternator should "drop out" between 30 and 31 volts.

CAUTION: If the alternator does not "drop out" at 31 volts, DO NOT proceed any further. (No Overvoltage Protection.) Re-adjust the regulator to 27.2VDC.

8. If the alternator does "drop out," turn the regulator adjustment screw back (counterclockwise) approximately ¼ turn and turn the master switch off at the dash.

9. Start the engine and adjust the regulator back to 27.2VDC.

10. If any one of the above test steps fails, replace the defective unit.

ENGINE HEATERS (OPTIONAL)

BLOCK AND OIL PAN HEATERS

An engine block heater is available as optional equipment. It is 115 volt, 1500 watt, single loop element type, fitted in the block behind the crankcase dipstick.

An oil pan immersion heater is also available as optional equipment. It is a 115 volt, 200 watt single loop element type fitted in the side of the oil pan.

Both heaters are supplied with a 3/16" HPN cord and plug set when ordered separately. When ordered together, or with the optional lavatory tank immersion heater, a junction box is supplied. This box is installed in an external access door at the rear of the coach.

These heaters are non-serviceable except for the cords and if faulty must be replaced.

ALARMSTATS (WITH NON-DDEC ENGINES)

Two alarmstats are installed, one at the front of each cylinder head to warn the operator if the engine overheats.

When the engine coolant rises to a specific temperature, the alarmstat closes the electrical circuit, causing the HOT ENGINE tell-tale light on the instrument panel to illuminate and the buzzer to sound in the driver's compartment. The activation of the alarmstats will cause the engine to automatically shut down.

Alarmstats are set to close at 210°F (99°C). An optional model that closes at 220°F (104°C) is also available. The temperature at which the alarmstat closes is stamped on the hex.

At time of general inspection, ground the alarmstats by making contact between the terminal post on top of the alarmstat and the alarmstat body. The warning buzzer should sound and the tell-tale light should illuminate, indicating that the wiring is in order. Remove any accumulation of dirt and grease from outside of alarmstats.

ELECTRIC HORNS

The coach is equipped with two 24-volt electric horns. They are located in the left hand front service compartment (figure 7-48).

The horns are operated by pressing a button at the center of the steering wheel or by using the electric foot switch. (When optional air horns are used, the foot switch is replaced by an air horn valve.) The tone is created by a vibrating diaphragm which causes an air column to vibrate.

No maintenance is normally required except a current adjustment of the adjusting screws. One horn produces a high note and the other a low note.

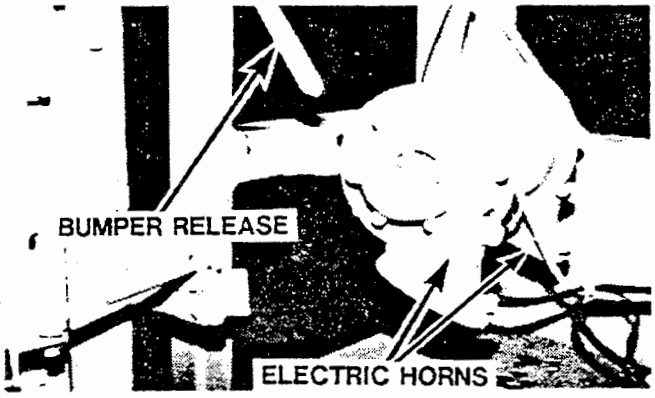


Figure 7-48. Horns.

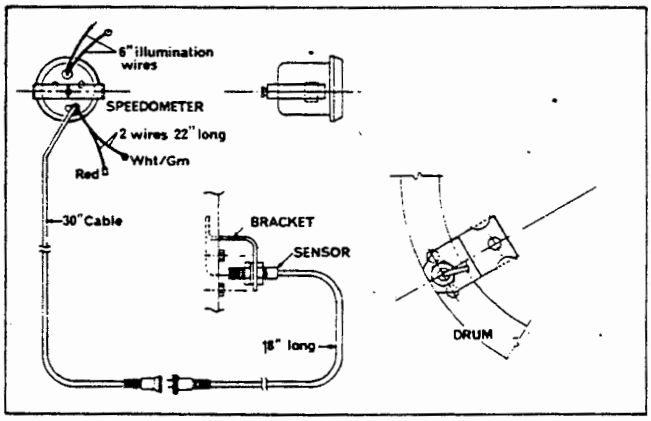


Figure 7-49. Electronic Speedometer Installation.

MC-9 MAINTENANCE MANUAL

SINGLE SENSOR SPEEDOMETER WITH LEFT FRONT WHEEL TAKEOFF

DESCRIPTION

A single sensor type speedometer with left front wheel takeoff is installed as standard equipment. The speedometer head is installed on the left side of the instrument panel. A single sensor is mounted on the backing plate on the left front wheel. Also four capscrews are mounted 180° apart on the backing plate.

OPERATION

As the left front wheel turns, the heads of the cap screws pass under the sensor. The sensor simply "counts" the number of times a cap screw head passes by. As they pass, a pulse is generated and sent up the cable to the speedometer head.

The gap between the sensor and cap screws is set at the factory and should not require adjustment. However, if the speedometer does not register at low speeds or high speeds, the following procedure should be followed to correct the situation.

PROCEDURE FOR CORRECTING SENSOR GAP

(A) Make sure all four cap screw heads pass approximately the same distance from sensor pickup.

(B) Start with a gap between sensor pickup and screw heads of about ⅛" (3mm).

(C) Watch the speedometer needle on the instrument panel as it slows down. The needle will begin to shake as the speed decreases. When the indicated speed drops to seven to five mph (12-9 km/h), the needle should suddenly drop to zero. If it continues to display a reading below 5 mph (9 km/h) the gap is too narrow and sould be widened slightly. If this is not done, the needle may shake and become erratic at highway speeds.

Conversely, if the needle drops to zero at 15 mph (23 km/h) or more, the gap is too wide and sould be narrowed slightly.

When adjusting the gap, always recheck speedometer reading to make sure the gap is increased or decreased correctly.

MC-9 MAINTENANCE MANUAL

ELECTRONIC SPEEDOMETER TROUBLESHOOTING

SYMPTOMS	POSSIBLE CAUSE	SOLUTION
A. No indication on meter.	A. 1) Magnets Off.	A. 1) Install magnets.
	2) Magnets very weak.	2) Install new magnets.
	3) Magnets not close enough.	3) Reposition magnets.
	4) Bad cable. (Can be verified by plugging in another cable and waving magnet past pickup).	4) Replace cable.
	5) Bad head. (Can be verified by plugging replacement head into installation cable and driving vehicle. Indication on new head determines cable O.K. but old head not.	5) Replace head.
B. Low reading on head.	B.	B.
1) Exactly half of correct reading and steady.	1) One magnet off.	1) Replace magnet.
2) (a) Exactly half of correct reading at high speeds but jumpy at low speeds.	2) (a) One magnet too far away from pickup.	2) (a) Reposition magnet.
(b) Exactly half of correct reading at high speeds but jumpy at low speeds.	(b) One magnet too weak.	(b) Replace magnet.
3) Low reading and unsteady at all speeds.	3) (a) Bad head	3) (a) Replace head & return it to factory.
	(b) Intermittently open cable. (Test by trying new head plugged into old cable and held by hand while vehicle is moving).	

MC-9 MAINTENANCE MANUAL

ELECTRONIC SPEEDOMETER TROUBLESHOOTING (Cont'd)

SYMPTOMS	POSSIBLE CAUSE	SOLUTION
4) Low reading just slightly but speady and same percentage low at all speeds.	4) Improperly calibrated head or wrong size tire.	4) Install proper head or recalibrate existing head.
C. High Reading.	C.	C.
1) High reading at all speeds but steady. Reads same percentage high at all speeds.	1) Head improperly calibrated or for different tire size.	1) Replace head with properly calibrated unit or recalibrate existing head.
2) Meter pinned at maximum reading.	2) (a) Bad head. Try new head in vehicle. (b) Shorted cable (if new head does the same thing or clears but is erratic as you move cable connector, this proves cable is not good).	2) (a) Replace head & return to factory. (b) Replace cable or clear short by disassembling connector and pulling on wires & carefully reassembling.
3) Reads two times too high exactly.	3) Magnets too close.	3) Move pickup away from magnets.
4) Reads two times too high at speeds (over 25-30) but accurate at Low speeds.	4) Magnets too close.	4) Move pickup away from magnets.
5) Reads 1-1/2 times too high exactly.	5) One magnet too close or to powerful.	5) Correct spacing depending upon reason for magnet being too close.
6) Reads 1-1/2 times too high at high speeds but accurately at low speeds.	6) One magnet too close or too powerful.	6) Correct spacing or replace magnet.

MC-9 MAINTENANCE MANUAL

ELECTRONIC SPEEDOMETER TROUBLESHOOTING (Cont'd)

SYMPTOMS	POSSIBLE CAUSE	SOLUTION
7) Difficult to define high reading which changes with amount of electrical equipment running in coach. (Heater, radio, fan, etc.)	7) Unit needs filter because of electrical hash or noise.	7) Install filter. (All serial numbers higher than M73xx or lower with white dot have filter inside).
8) Jumpy needle.	8) (a) Needs filter (b) Intermittent short in cable. Check by trying new cable.	8) (a) Install filter. (b) Replace cable.
D. Needle reads above zero.	D.	D.
1) With power off.	1) Incorrect zero adjust setting.	1) Replace head or carefully remove glass and readjust.
2) With power on.	2) Leaky transistor.	2) Replace head & return it to factory.
E. Combination of any of the above.	E.	E. Correct problems each in order.
F. Needle sticks at one spot.	F.	F.
1) Jumps both going up and down the scale.	1) Bad Head.	1) Replace.

MC-9 MAINTENANCE MANUAL

LIGHT BULB DATA

EXTERIOR LAMPS	NUMBER
Headlamps - Low Beam	H5006
Headlamps - High Beam	H4001
Fog Lamps (Clear, Sealed Beam)	4880
Side Turn Signal Lamps (Front Side)	1638
Stop Lamps	1683
Destination Sign Lamps	1691 IF
Tail Lamps	1252
Rear License Plate Lamps	624
Center Identification Lamps	624
Roof Corner Clearance Lamps (Side)	624
Side Marker Lamps	624
Intermediate Side Marker Lamps	624
Side Turn Signal Lamps (Rear Side)	1638
Backup Lamps	1638
Turn Signal Lamps	1638

INTERIOR LAMPS	NUMBER
Window Fluorescent Lamps	F40/WW
Overhead Aisle Fluorescent Lamps	F30 T12/WW/RS
Turn Lamp	265 Green
Generator Discharge - Remote Control Panel	456
Lavatory OCCUPIED Sign	265
Trailing Axle	265
Low Water Level	265
Low Fuel Level	456
Fire Alarm	265
Auto Transmission Illumination	265
Engine Compartment	456
Lavatory Main Lamp	1638
Lavatory Night Lamp	1495
Reading Lamps	1691 IF
Indirect Lamps	1495
Driver's Lamp	1203
Switch Panel Illumination Lamps	265 Green
Instrument Panel Lamps (Green)	757
Step Lamp	624
Baggage Compartment Lamps	308 IF
Engine Compartment Lamps	456
Running Lamps (blue)	1495
In-Station 115V - Baggage	25T8
In-Station 115V - Destination	15T7 DC/IF
In-Station 115V - Ceiling, Fluorescent	15T8
Heat On (green)	265
Air Conditioning (red)	456
Low Oil (red)	456
Not Gen (amber)	265
Emergency Brake (green)	456
Lavatory Emergency (red)	265
Low Air (red)	456
Hot Engine (red)	456
Back-Up Lamps (green)	456
High Beam (blue)	265
Hazard Warning Flasher (green)	265
Stop Lamps (green)	265
Fog Lamp (green	265
Aisle Lamps (seat) (blue)	1251
Speedometer Lamp (green)	356

MC-9 MAINTENANCE MANUAL

AIR CONDITIONING JUNCTION BOX CONNECTIONS

STUD	CIRCUIT NUMBER	COLOR	GAUGE	DESCRIPTION
1	14	White-Red	16	Diode to Stud 8 - Coach Heat Sensing Unit
2	16	Black	16	Sensing Element A and Potentiometer
3	31	Green-Black	14	Baggage Compartment Lamps
4	44	Yellow	16	Left Hand Turn Lamps
5	45	Yellow-Red	16	Right Hand Turn Lamps
6	23	White-Green	16	Spare
6		Black	10	12-Volt Power Source
7	56 & 56A	Green	18	Hot Water Valve
8	55	Orange	16	Sensing Element C
9	21	Blue-White	16	12-Volt Headlight Relay
10	66	Orange-White	16	Spare
11	14H (3 wires)	White-Green	14	A/C Tell-Tale and Liquid Line Solenoid
12	70	White-Green	18	Spare
13	53	Black-Blue	16	Fuel Gauge (Optional) or Fuel Sensor (Optional)6
14	47	Red-Yellow	14	Evaporator Motor Relay
15	14P	Green-Yellow	16	Condenser Motor Relay Coil

REMOTE CONTROL BOX (HORIZONTAL BAR)

1	14P	Green-Yellow	16	Hi-Lo Pressure Switch Feeder
2	14L	Yellow	16	A/C Clutch
2	14H	White-Green	16	Liquid Line Solenoid
2	BL	Black	16	Hi-Lo Pressure Switch
3	14L	Yellow	16	Spare
4	46	Orange-Red	16	Back-Up Lamp
5	44	Yellow	16	Left Hand Turn Lamp
6	46G	Blue	16	Back-Up Lamp (Return)
7	24	Green-Yellow	16	Left Hand Stop Lamps
8	15	Red-Blue	16	Spare
9	6A	Blue-Yellow	16	Engine Stop Valve
10	54	Yellow	16	Spare

REMOTE CONTROL BOX (VERTICAL BAR)

1	17	Red-Black	16	License Plate Lamps
2	15	Red-Blue	16	Tail Lamps
2	15	Red-Blue	16	Side Marker Lamps
3	24	Green-Yellow	16	Right Hand Stop Lamps
4	31	Green-Black	16	Motor Compartment Service Lamps
5	45	Yellow-Red	16	Right Hand Turn Lamps
6	57	Yellow-Green-Green	16	Spare
7	63	Blue-Blue	16	Lavatory Blower
8	63A	Red-Blue	16	Spare

MC-9 MAINTENANCE MANUAL

FRONT JUNCTION BOX CONNECTIONS

Stud	Circuit Number	"Color Codes" All Harnesses Except Driver's Instrument Panel	Gauge	Description
1	26	Orange-Black	16	Oil Pressure Gauge
2	27	Brown	16	Temperature Gauge
3	42	Blue	18	Potentiometer Rotor
4	29	Red-Black	14	Front/Rear Start Switch
5	41	Black-Red	16	Horn Relay
6	44F	Yellow	16	Turn Lamp - Left Front
7	44R	Yellow	16	Turn Lamp - Left Rear and Side
8	45F	Yellow-Red	16	Turn Lamp - Right Front
9	45R	Yellow-Red	16	Turn Lamp - Right Rear and Side
10	25	Gray	14	Emergency Engine Stop
11	5	White-Red	18	24V Discharge Tell-Tale Light
12	OR	Black	18	Starter Alert Tell-Tale Light
13	38	White-Green	18	Low Air Tell-Tale Light
14	3	Black	10	Load Side of Master Switch
14	3	Black	14	Instrument Feeder
14	3	Black	10	Bus Bar Circuit Breaker Feeder (Rear)
15	15	Red-Blue	14	Marker Lamps
15	15	Red	12	Marker Lamps Feeder (Load Side)
16	21	Blue-White	16	Aisle Lamps
16	21		16	Running Lamps
16	43	Green-White	16	Gauge Illumination (Feeder)
17	69	Red-Blue	16	Reverse Throttle Interlock
18	47	Red-Yellow	14	Evaporative Motor Relay Feeder
19	24P	Green-Yellow	16	Stop Lamp Feeder
	9P	Black-Green	18	Feeder-Door Latch-Solenoid Valve
20	24	Green-Yellow	16	Stop Lamps
21	28	Brown-Yellow	16	Lavatory Alarm
22	36C	White	18	Master Control Switch-Galley (Option)
23	22	Black-Yellow	16	Driver's Lamp
24	20	Yellow	12	Indirect Lamp Feeder
	20R & 20L	White-Red (2 wires)	14	Indirect Lamps
25	31	Green-Black	14	Baggage Compartment Lamps
26	39P	Red-White	16	Emergency Brake Tell-Tale & Fast Idle
	24P	Green-Yellow	18	Door Lock Feeder
	3	Black	16	Master Circuit - Emergency Brake Switch & Fast Idle
	3	Black	16	Master Circ. (Load Side) Emg. Brake Switch & Fast Idle Switch
27	35	White-Black	16	High Beam Tell-Tale Light
28	33	Red-Black	12	Feeder-Headlight to Dimmer Switch
28	21	White-Blue	16	12V Cut-Off Relay (Headlights)
29	63A	Maroon	14	Auxiliary A/C (Option)
30	54	Yellow	14	Heating-A/C Feeder
31	55	Orange	16	Sensing Element C
32	50	Green-Red	16	Fire Detector
33	7R	Black-White	14	Right Hand Reading Lights
34	14P	Green-Yellow	16	A/C Malfunction Tell-Tale Light
35	53	Black-Blue	16	Fuel Gauge (Option) or Fuel Level Sensor
36	36A	White	16	Additional Lavatory OCCUPIED Light
37	76	White-Green	18	Driver's Freon Valve
38	30	Brown-White	16	Alarmstat-Hot Engine Sensor and Buzzer
39	32	Orange-Green	16	Jacobs Engine Brake (Option)
40	18	Black-White	16	Low Air Tag Axle Solenoid Valve Feeder
41	46G	Blue	16	Back-Up Lamp Ground Return
42	16	Black	16	Sensing Element A & Potentiometer
43	56	Green	16	Hot Water Valve
44	37	White-Red	16	Step Lamp & Chime Feeder

MC-9 MAINTENANCE MANUAL

FRONT JUNCTION BOX CONNECTIONS (Cont'd)

Stud	Circuit Number	"Color Codes" All Harnesses Except Driver's Instrument Panel	Gauge	Description
45	7L	Maroon	14	Left Hand Reading Lamps
46	40	Gray	16	Fast Idle - Load Side
47	40P	Gray	16	Fast Idle - Line Side
	39	Red-White	16	Emergency Brake Tell-Tale Light & Air Switch
48	59	Yellow-Black	16	Jacobs Engine Brake (Option)
49	66	Orange-White	16	Heated Mirror Switch (Option)
50	60	Yellow	18	3-Lb. Oil Sender
	32	Orange-Green	16	3-Lb. Oil Switch at Dash
51	10	Black-Red	18	Low Water Level Sensor
52	52	Brown-Black	16	Fog Lamp Tell-Tale
53	9	Black-Green	18	Door Latch Skinner Valve
54	58	Blue	16	Rear Wheel Sanders (Option)
55	23	Black	10	12V Power Source - 10 Amp
	23	White-Green	14	Spare
56	61	Orange-Red	16	Jacobs Engine Brake (Option)
57	57	Yellow-Green	16	A/C Control Feeder
A	18A	Black-White	18	Tachograph (Option) or Electronic Speedometer
B	B	Green-White	18	Low Air Tag Axle Tell-Tale Light
C	C	White-Black	18	Tachograph or Tachometer
D	D	Brown-Black	18	Cruise Control (Signal from Sensor) (Option)
WH	WH	White	18	Tachograph (Option)
BR	14H	White-Green	16	Compressor Clutch and Liquid Line Solenoid
GR		Green	18	N-C Spare to Rear
BL	BL	Black	18	Transmission Temperature Tell Tale
	230	Grey-Red	14	Aux. A/C
	36B	White	18	24-12VDC Power Converter (Emerg. Radio Power)
	15B	Red-Blue	16	Marker Lights on Separate Toggle Switch
	45B	Yellow-Red	16	Flashing Warning Lights on 4 Roof Corners

MC-9 MAINTENANCE MANUAL

REAR JUNCTION BOX CONNECTIONS

Stud	Circuit Number	"Color Codes" All Harnesses Except Driver's Instrument Panel	Gauge	Description
1	68A	Orange-Black	14	Parcel Rack A/C Unit From A/C Box Circuit Breaker
1	56A	Green	16	Spare
2	54	Yellow	14	Heating and Air Conditioning
3	15	Red-Blue	14	Marker and License Plate Lamps
3	17	Red-Black	14	Tail Lamps
4	24	Green-Yellow	16	Stop Lamps
5	46G	Blue	16	Back-Up Lamps
6	45	Yellow-Red	16	Right Hand Turn Lamps
7	44	Yellow	16	Left Hand Turn Lamps
8	45B	Yellow-Red	16	Flashing Warning Lights at 4 Roof Corners
9	57	Yellow-Green	16	Spare
9	70	White-Green	18	N.C. Spare
10	27	Brown	16	Water Temperature Gauge
11	59	Yellow-Black	16	Jacobs Engine Brake (Option)
12	29	Red-Black	14	Starter Switch
12	29	Red-Black	14	Remote Starter Switch
13	60	Yellow	16	Engine Stop Switch Relay No. 7
Relay	6	Blue	16	Engine Stop (Battery) No. 2
14	18	Black-White	16	Low Air Tag Axle
15	29S	Black-White	14	Starter Solenoid Relay
16	46	Orange-Red	16	Back-Up Lamp
17	69	Red-Blue	16	Reverse Throttle Interlock
18	62	Green-Black	16	Lavatory Dome Lamp
18	31	Green-Black	16	Motor Compartment Service Lamps
19	32A	Orange-Green	16	Jacobs Engine Brake (Option)
20	5&49	White-Red	18	24V Discharge Lamp
21	30	Brown-White	16	Alarmstat-Hot Engine Sensor
22	40	Gray	16	Fast Idle
23	25	Gray	14	Emergency Engine 8V-71
24	3	Black	10	Load Side Master Circuit
25	3	Black	14	Engine Stop Relay
25	4	Green-Red	14	Rear Stop and Start Switch Feeder
26	OR	Black	18	Tell-Tale Light for Triple Function Protective Device (Option)
27	14	White-Red	16	Spare
28	36A	White	16	Additional Lavatory OCCUPIED Light
29				Spare
30	3A	Black	16	Low Water Level Sensor
31	10	Black-Red	18	Low Water Level Sensor
32	50	Green-Red	16	Fire Detectors (Option)
33	R1	Black-Red	16	24V Discharge Relay Feeder and Blower Cut-In
34	26	Orange-Black	16	Oil Pressure Gauge
35	63	Blue-Blue	16	Lavatory Blower
36	57	Yellow-Green	16	A/C-Feeder-Main Harness
36	14P	Green-Yellow	16	Hi-Lo Pressure Switch Feeder Tell-Tale and Condenser Relay Coil
37	28P	Brown-Yellow		Lavatory Buzzer
38	28	Brown-Yellow	16	Lavatory Buzzer Feeder
39	15B	Red-Blue	16	Marker Lights on Separate Toggle Switch
Relay	36C	White	16	Master Cut-Off Switch-Galley (Option)
40	14P	Green-Yellow	16	Condenser Relay Coil
40	14P	Green-Yellow	16	Low Pressure Tell-Tale
40	14P	Green-Yellow	16	A/C Safety Switches
41	23A	White-Green	16	12V Option Rear
42	58	Blue	18	Rear Wheel Sanders (Option)
43	63A	Red-Blue	14	Auxiliary A/C (Option)
44	60	Yellow	16	Common on Rectifier (Option)

MC-9 MAINTENANCE MANUAL

REAR JUNCTION BOX CONNECTIONS (Cont'd)

Stud	Circuit Number	"Color Codes" All Harnesses Except Driver's Instrument Panel	Gauge	Description
45	60	Yellow	18	Engine Stop Relay
46	60A	Yellow	18	Spare
47	30A	Brown-White	16	Spare
48	F1	Yellow	12	Alternator Field "F1"
49	A1	Yellow-Black	12	24V Regulator
50	61	Orange-Red	16	Jacobs Engine Brake (Option)
51	60	Yellow	18	3 lb. Low Oil Switch (Std.) N.C. Spare
52				Spare
53	6	Blue-Yellow	16	Engine Stop Relay - Terminal 5
53	6	Blue-Yellow	16	Engine Stop Relay & Switch - Line Side
54	6A	Blue-Yellow	16	Engine Stop Valve - Load Side of Switch
55	10A	Black-Red	16	Low Water Level Sensor
56	3A	Black	16	Low Water Level Sensor
57	3A	Black	16	Spare
A	18A	Black-White	16	Elec. Tachometer or Speedometer
B	B	Green-White	18	Lo Air Trailing Axle Tell-Tale Light
C	C	White-Black	18	Tachometer
D	D	Brown-White	18	Tachometer or Speedometer
WH	WH	White	18	Speedometer or Elec. Tachometer
BR	14H	White-Green	16	A/C Tell-Tale & Liquid Line Solenoid
GR	38	Green	18	Low Air Tell-Tale Light
BK	BL	Black	18	Speedometer Spare
Relay	36B	White	18	24-12V Power Converter

MC-9 MAINTENANCE MANUAL

SPECIFICATIONS

ALTERNATOR

Manufacturer	Delco-Remy
Part No.	7G-3-42
Model Number	11177702
Field Current at 80°F (27°C)	
Amperes	7.2-8.0
Volts 24 volts Hot Output	
Amperes	270 at 80°F (27°C) ambient
Volts	28 volts
Approximate RPM	3000
Ground	Negative

REGULATOR (24-VOLT)

Manufacturer	Delco-Remy
Part No.	7G-4-1
Model Number	1118447
Type	Transistor
Voltage Adjustment	External Screw

BATTERIES (24-VOLT SYSTEM)

Ampere Hour Capacity at 20 Hour Rate	225
Number of Plates Per Cell	29
Separators	Plastic
Reserve Capacity	393 mins.
Cold Cranking At 0°F (-18°C)	975 amps
Weight Dry	104 lbs. (47 kg)
Weight Wet	146 lbs (66 kg)
Acid to Fill	16.2 Qts. (U.S.) (15.4 liters)
Number of Batteries	1
SAE Number	8D
Grounded Terminal	Negative

STARTER MOTOR

Manufacturer	Delco-Remy
Model/Part Number	42MT/7G-1-39
	40MT/7G-1-1
	50MT/7G-1-38*
Rotation (Viewing Drive End)	CW
Pinion Clearance	**354 ± .031" (9mm ± .79 mm)**
No-Load Test	
7G-1-39 (42MT)	
Volts	20
Current Draw (Amps)	60 Min., 75 Max.
RPM	6500 Min., 7700 Max.
7G-1-1 (40MT)	
Volts	20
Current Draw (Amps)	70 Min., 110 Max.
RPM	5500 Min., 9000 Max.

MC-9 MAINTENANCE MANUAL

SPECIFICATIONS (Cont'd)

7G-1-38 (50 MT)

Volts	20 volts
Current Draw (Amps)	95 min., 120 max.
RPM	5500 min., 7500 max

* With 8V92 Engine.

STARTER SOLENOID

Manufacturer	Delco-Remy
Part Number	7G-1-84 (with 42 MT Starter)
	7G-6-25 (with 40 MT & 50 MT Starters)
Test Specifications	
7G-1-84	
Pull-In-Winding	8.5-10.0 Amps at 5 VDC
Hold-In Winding	11.0-15.0 Amps at 20 VDC
7G-6-25	
Pull-In-Winding	9.0-11.5 Amps at 5 VDC
Hold-In Winding	6.8 Amps Max. at 20 VDC

ALARMSTAT (NON-ADJUSTABLE TYPE)

Manufacturer	Kysor
Model Number	1002-05511-34
Part No.	8G-28-7
Contact Points Close At	210°F (99°C)
Model Number (Optional)	1002-05511-36
Part No.	8G-28-8
Contact Points Close At	220°F (104°C)

LOW AIR PRESSURE SWITCH

Manufacturer	Nason
Part No.	7J-13-229
Terminals	3
Circuit	SPD1
Maximum Operating Pressure	500 psi
Operation	Contacts set to transfer at 100 psi (max.) increasing pressure Contacts reset at 70 psi as pressure decreases
Setting Tolerance	100 psi (+0, −10 increasing), 70 psi (±5 decreasing)

MC-9 MAINTENANCE MANUAL

WIRING DIAGRAM INDEX

TITLE	PAGE
Air Conditioning Junction Box Decal	7-63
Alarm & Telltale Wiring Diagram	7-47
Charging & Starting Wiring Diagram	7-49
Circuit Breaker Location - Rear Junction Box	7-64
Cruise Control Wiring Diagram	7-58
Exterior Lighting Wiring Diagram	7-44
Front Junction Box Decal	7-61
Front Junction Box Relay Location Decal	7-62
Headlamp Wiring Diagram	7-43
Heating & Air Conditioning Wiring Diagram	7-46
Interior Lighting Diagram	7-45
Instrument Wiring Diagram	7-53
Low Coolant Level Wiring Diagram	7-55
Mini Galley Wiring Diagram	7-66
Motor Control Wiring Diagram	7-48
Pressurized Ether Start Wiring Diagram	7-60
Rear Junction Box Relay Location Decal	7-65
Sigmanetics Tachometer Wiring Diagram	7-51
Starting Circuit with Thermal Time Delay Relay Wiring Diagram	7-59
Stereo Speaker Diagram	7-54
Trailing Axle Unloading Wiring Diagram	7-56
Transmission Wiring Diagram	7-57
Two Speed Governor Wiring Diagram	7-50
Voltmeter Installation & Wiring Diagram	7-52
Wiring Diagram Symbols	7-41

MC-9 MAINTENANCE MANUAL

WIRING DIAGRAM KEY


ILLUMINATING LAMP


INDICATING LAMP



BUZZER


FLASHER

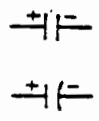


ELECTRIC MOTOR/LOAD


METER/GAUGE


RESISTOR


VARIABLE RESISTOR


CERAMIC CAPACITOR


ELECTROLYTIC CAPACITOR

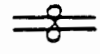

VARIABLE CAPACITOR/RHEOSTAT


POTENTIOMETER

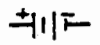

WIRES CROSSING

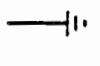

WIRES CONNECTED


WIRES GROUPED

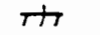

SHIELDED WIRES


EXTERIOR PLUG RECEPTACLE


BATTERY

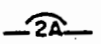


GROUND

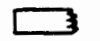


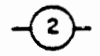


FUSE



CIRCUIT BREAKER


BUS BAR



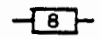
ENGINE TERMINAL BLOCK STUD



ENGINE CRADLE HARNESS PLUG



FRONT JUNCTION BOX STUD



REAR JUNCTION BOX STUD



AIR CONDITIONING JUNCTION BOX STUD



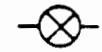
SENSING ELEMENTS PLUG

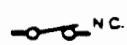


REMOTE CONTROL BOX, HORIZONTAL BLOCK STUD

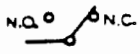


REMOTE CONTROL BOX, VERTICAL BLOCK STUD

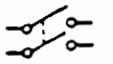

ROOF HARNESS BLOCK STUD

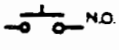


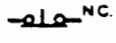
SPST - SINGLE POLE, SINGLE THROW SWITCH/KEY SWITCH



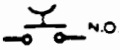
SPDT - SINGLE POLE, DOUBLE THROW SWITCH/KEY SWITCH


DPST - DOUBLE POLE, SINGLE THROW SWITCH

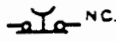




MOMENTARY CONTACT PUSH BUTTON SWITCH



PRESSURE/VACUUM ENERGIZED SWITCH

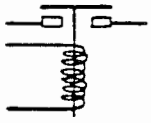


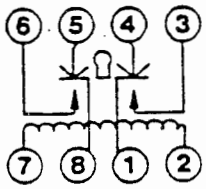
MC-9 MAINTENANCE MANUAL

WIRING DIAGRAM KEY (CONT'D)

FIELD WINDING

RELAY



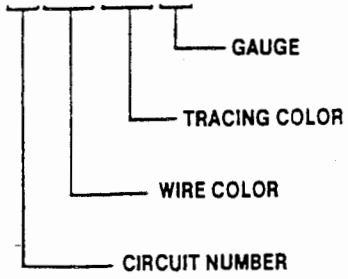


RELAY

MAGNETIC CORE TRANSFORMER

BK	BLACK
BL	BLUE
BR	BROWN
GR	GREEN
GY	GREY
MR	MAROON
OR	ORANGE
YL	YELLOW
WH	WHITE

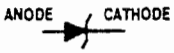
#35 BK BL 16 WIRE CODING:



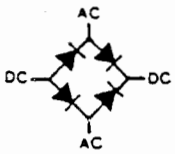
DIODE/RECTIFIER



ZENER DIODE

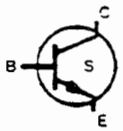


FULL WAVE RECTIFIER

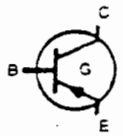


TRANSISTOR

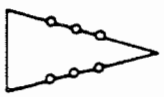
NPN (S-SILICON)



PNP (G-GERMANIUM)



INTEGRATED CIRCUIT (IC)

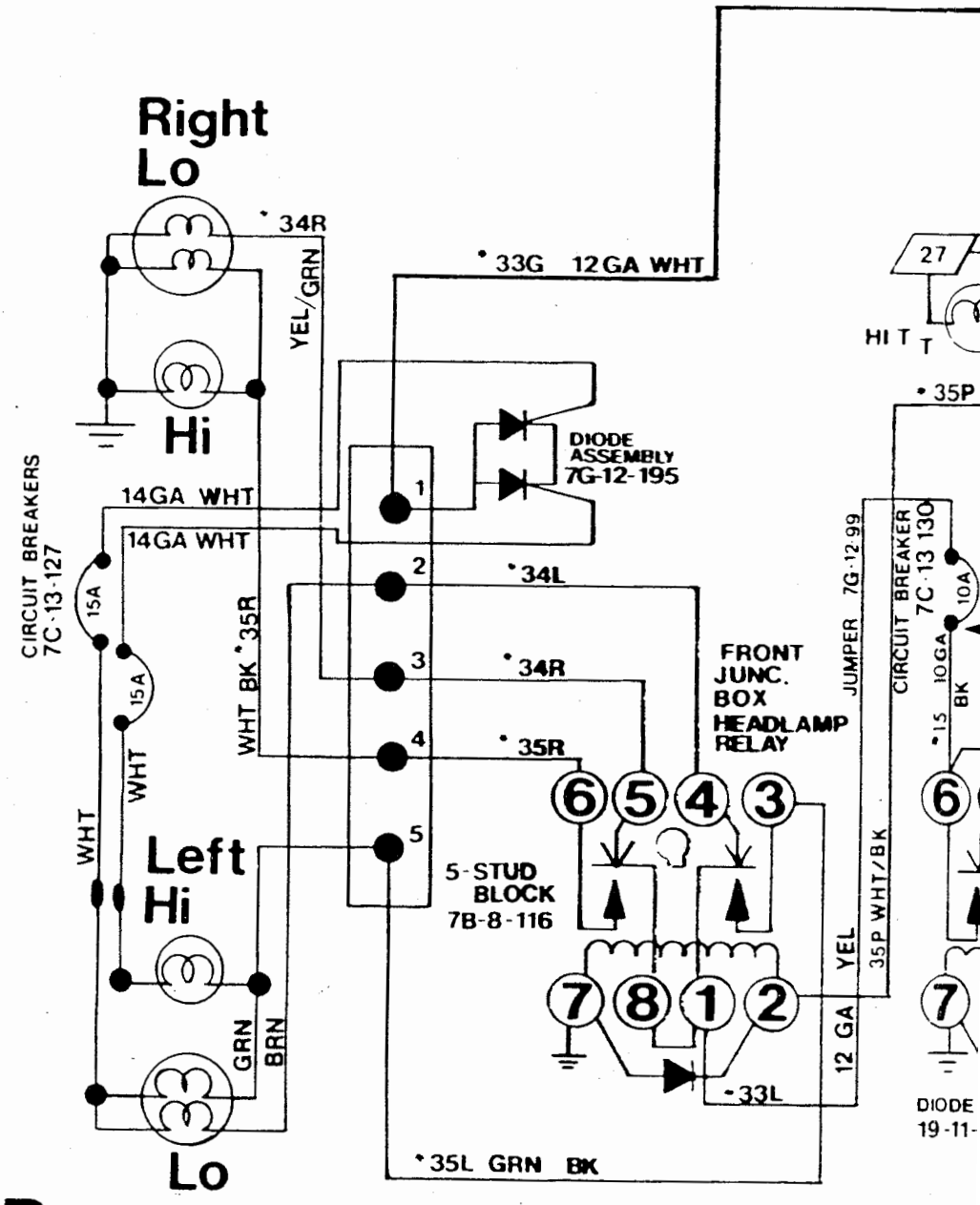


METRIMATE CONNECTORS

(P1) GAUGES
(P2) LH TELL-TALES
(P3) RH TELL-TALES
(P4) RH SWITCHES
(P5) LH SWITCHES
(P6) PANEL TO LEFT OF DRIVER



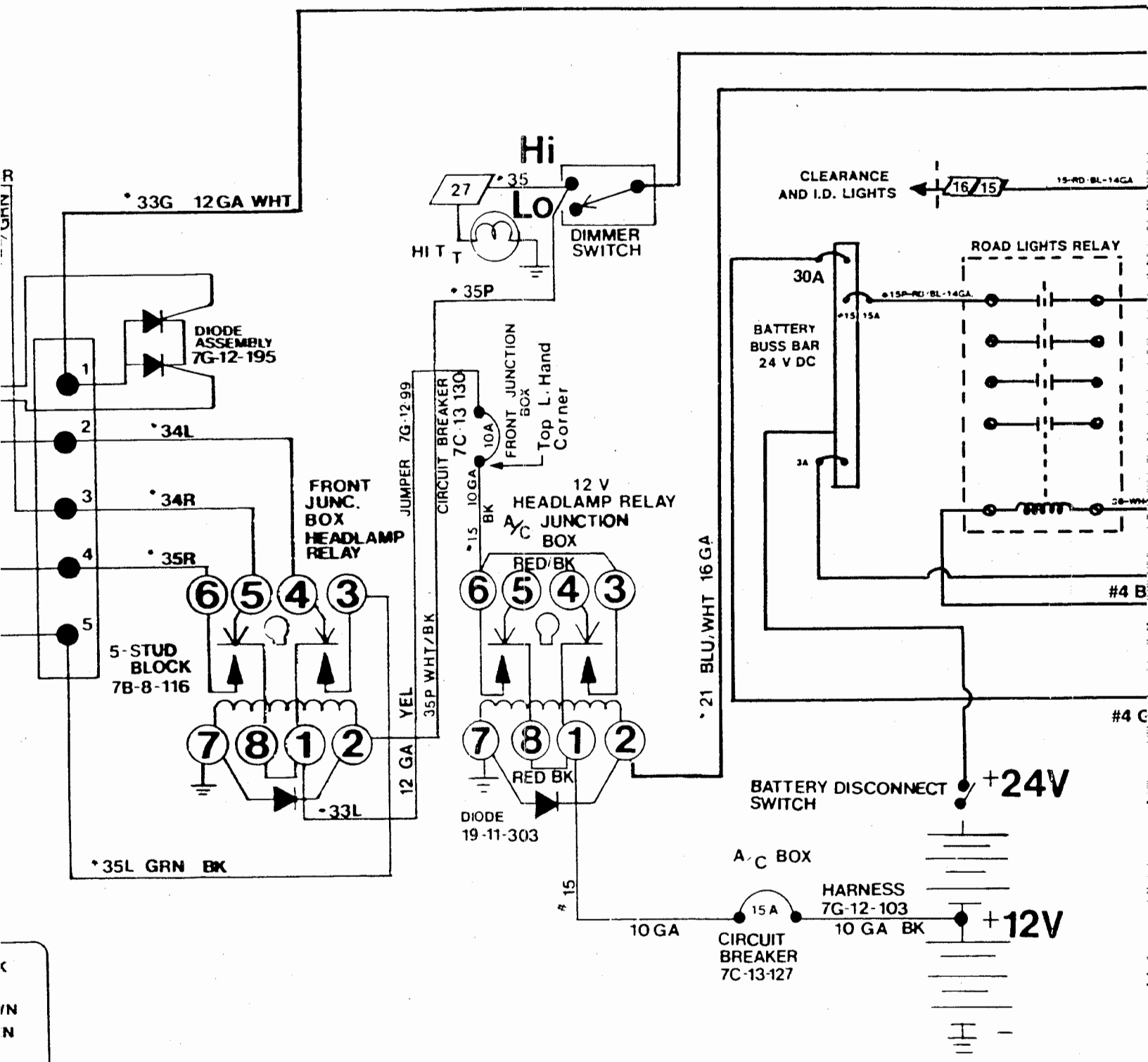
METRIMATE CONNECTOR PIN

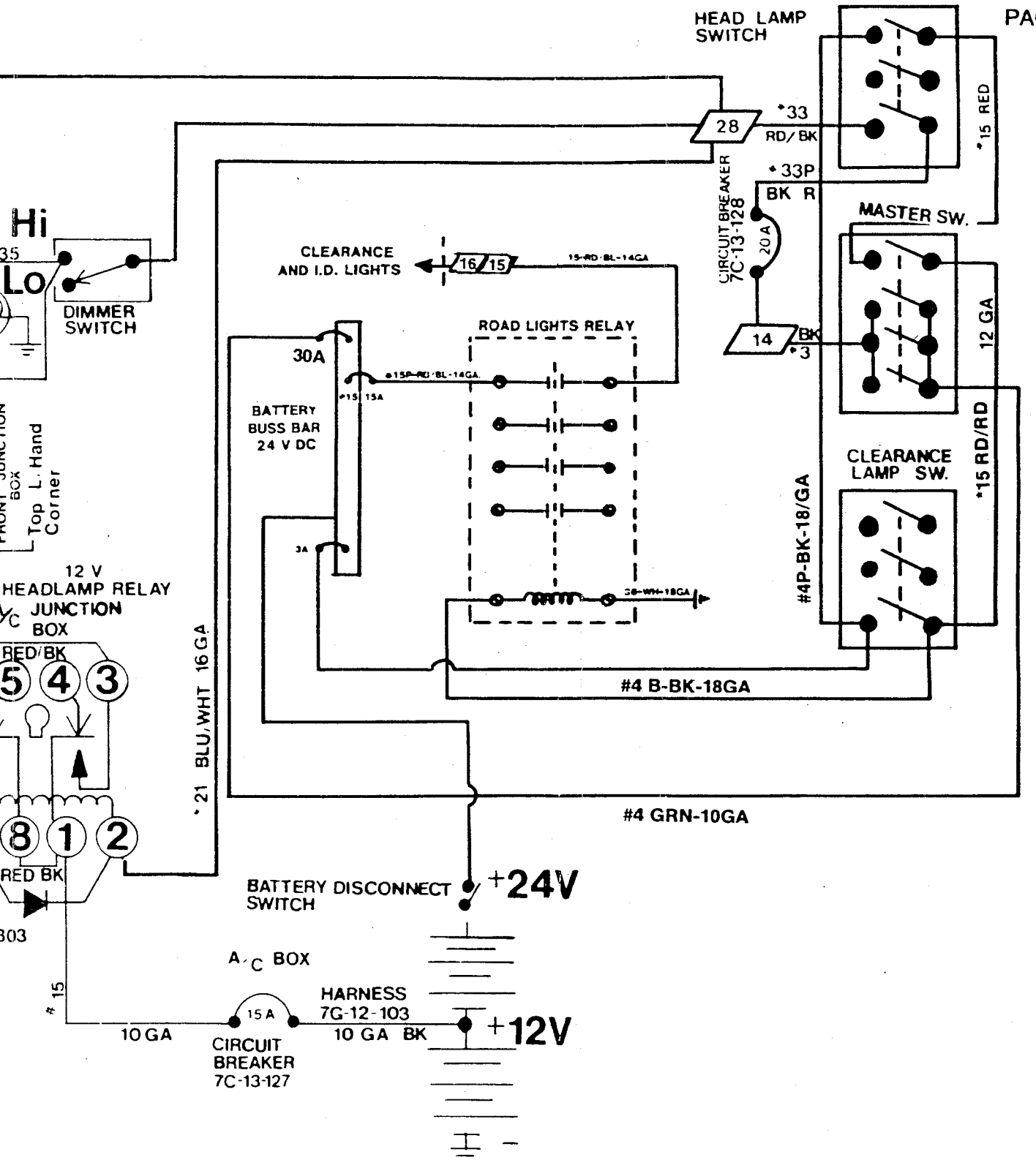


LEGEND

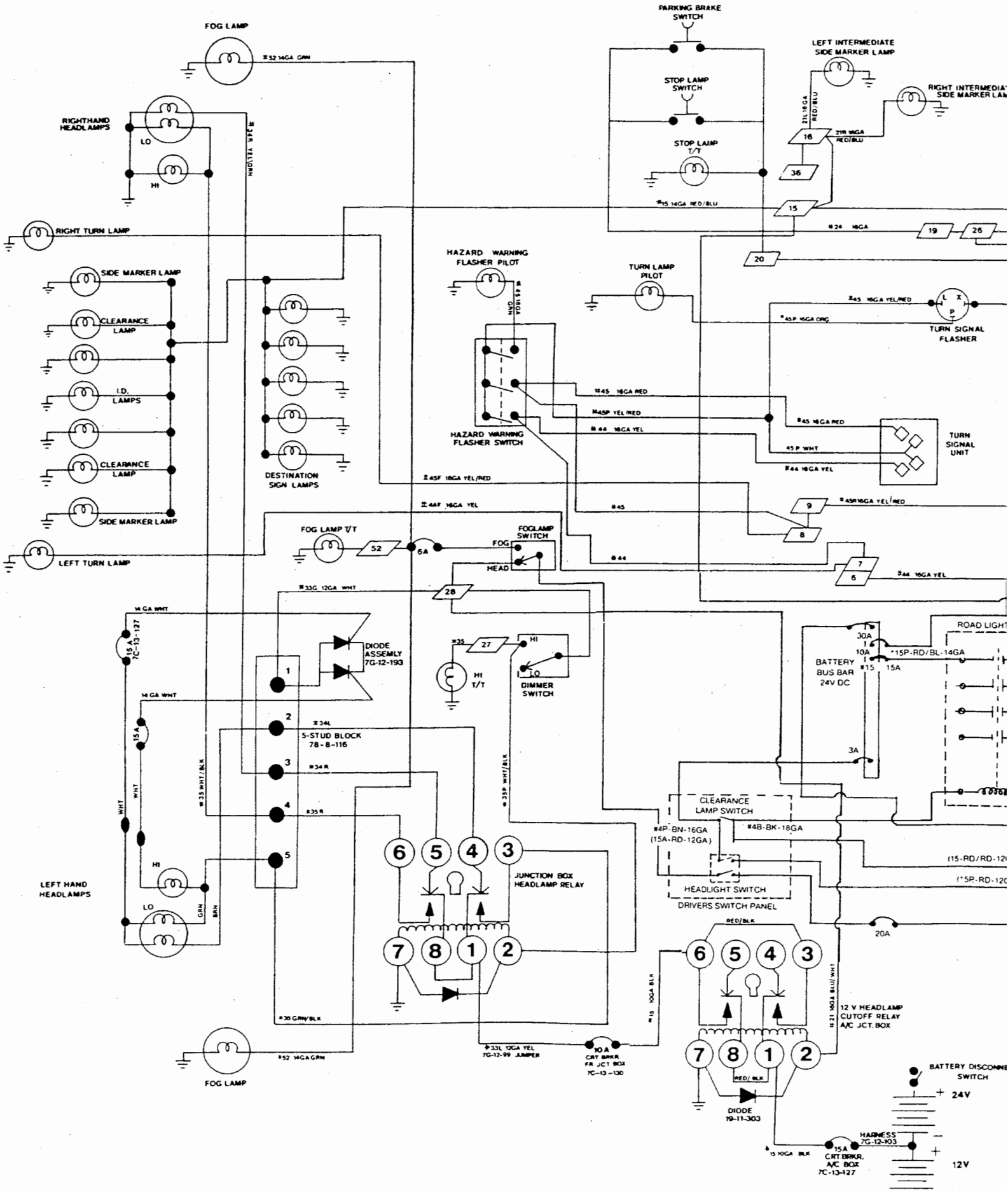
- FRONT JUNCTION BOX STUD
- REAR JUNCTION BOX STUD
- AIR CONDITIONING JUNCTION BOX STUD
- SENSING ELEMENT PLUG
- REMOTE CONTROL BOX HORIZONTAL BLOCK STUD
- REMOTE CONTROL BOX VERTICAL BLOCK STUD
- ② ENGINE TERMINAL BLOCK STUD
- Ⓑ ENGINE CRADLE HARNESS PLUG
- ROOF HARNESS BLOCK STUD
- * OPTION

- BLK - BLACK
- BLU - BLUE
- BRN - BROWN
- GRN - GREEN
- GRY - GRAY
- MAR - MAROON
- ORG - ORANGE
- RED - RED
- WHT - WHITE
- YEL - YELLOW


Hi
Lo
27
*35
DIMMER SWITCH
HI T T
*35P
*33G 12 GA WHT
DIODE ASSEMBLY 7G-12-195
1
2
3
4
5
*34L
*34R
*35R
FRONT JUNC. BOX HEADLAMP RELAY
6 5 4 3
7 8 1 2
5-STUD BLOCK 7B-8-116
JUMPER 7G-12 99
CIRCUIT BREAKER 7C-13-130
10A
FRONT JUNCTION BOX
Top L. Hand Corner
10 GA BK
*15
12 V HEADLAMP RELAY
A/C JUNCTION BOX
RED/BK
RED BK
DIODE 19-11-303
35P WHT/BK
YEL
12 GA
-33L
*35L GRN BK
*21 BLU,WHT 16 GA
CLEARANCE AND I.D. LIGHTS
16 15
15-RD-BL-14GA
ROAD LIGHTS RELAY
30A
BATTERY BUSS BAR 24 V DC
*15 15A
3A
#4 B
#4 G
BATTERY DISCONNECT SWITCH
+24V
A/C BOX
HARNESS 7G-12-103
10 GA BK
+12V
#15
10 GA
15 A
CIRCUIT BREAKER 7C-13-127
–



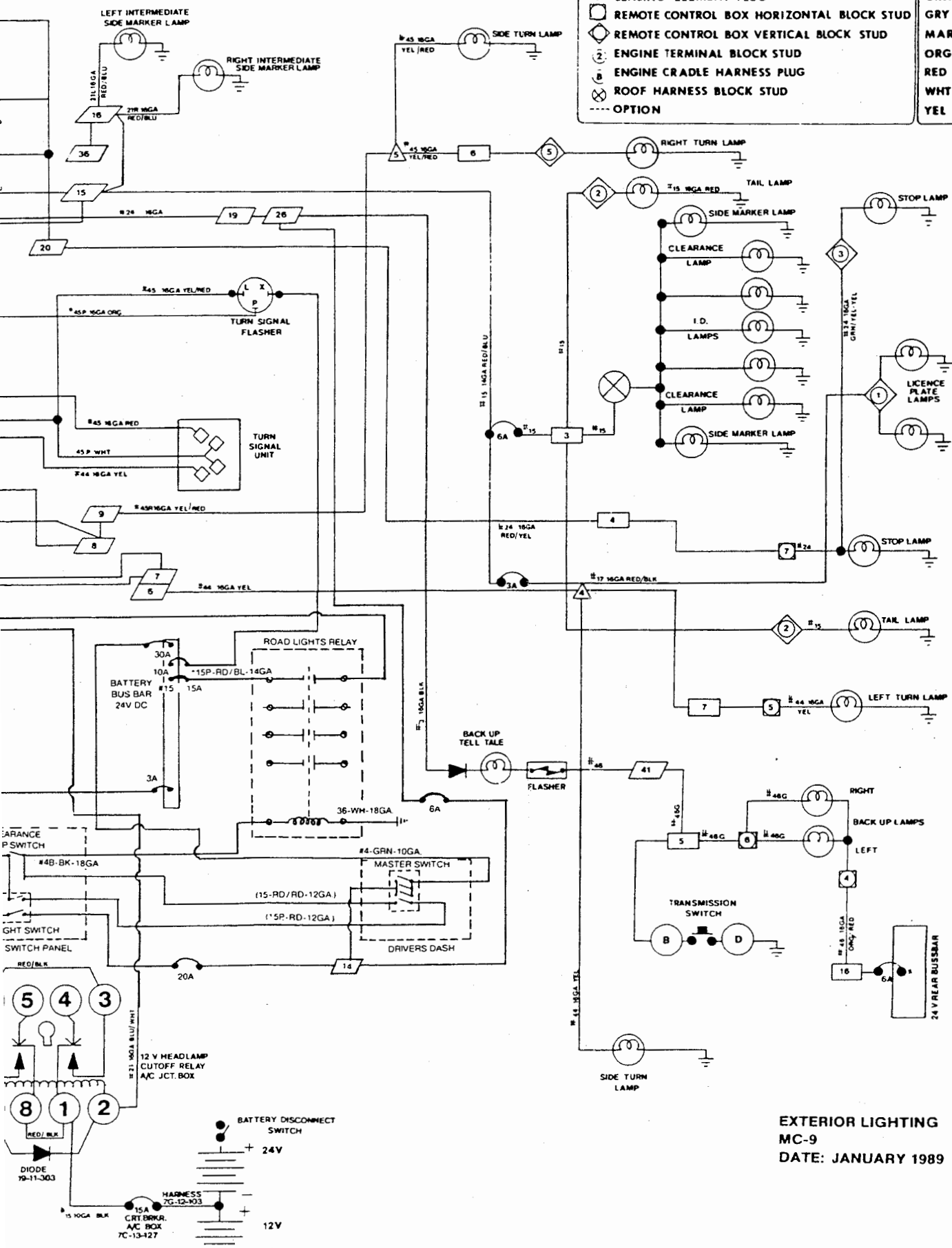
12V HEADLAMP WIRING
MODEL: MC-9
DATE: JAN. 1989


FOG LAMP
#52 14GA GRN
RIGHTHAND HEADLAMPS
LO
HI
#34R YEL/GRN
RIGHT TURN LAMP
SIDE MARKER LAMP
CLEARANCE LAMP
I.D. LAMPS
CLEARANCE LAMP
SIDE MARKER LAMP
LEFT TURN LAMP
DESTINATION SIGN LAMPS
PARKING BRAKE SWITCH
STOP LAMP SWITCH
STOP LAMP T/T
#15 14GA RED/BLU
LEFT INTERMEDIATE SIDE MARKER LAMP
RIGHT INTERMEDIATE SIDE MARKER LAMP
21L 18GA RED/BLU
21R 18GA RED/BLU
16
36
15
#24 18GA
19
26
20
HAZARD WARNING FLASHER PILOT
#45 18GA GRN
HAZARD WARNING FLASHER SWITCH
TURN LAMP PILOT
#45 16GA YEL/RED
#45P 16GA ORG
TURN SIGNAL FLASHER
#45 16GA RED
#45P YEL/RED
#44 16GA YEL
45P WHT
TURN SIGNAL UNIT
#45F 18GA YEL/RED
#44F 16GA YEL
#45
#45R 16GA YEL/RED
9
8
7
6
#44
#44 16GA YEL
FOG LAMP T/T
52
6A
FOGLAMP SWITCH
FOG
HEAD
#33G 12GA WHT
28
14 GA WHT
15A 7C-13-127
DIODE ASSEMBLY 7G-12-193
1
#35
27
HI
LO
HI T/T
DIMMER SWITCH
2
#34L
5-STUD BLOCK 78-8-116
3
#34 R
4
#35 R
#35 WHT/BLK
#39P WHT/BLK
WHT
WHT
15A
HI
LO
GRN
BRN
LEFT HAND HEADLAMPS
5
6 5 4 3
JUNCTION BOX HEADLAMP RELAY
7 8 1 2
#35 GRN/BLK
#52 14GA GRN
FOG LAMP
#33L 10GA YEL 7G-12-99 JUMPER
10A CRT BRKR. FR. JCT BOX 7C-13-130
#15 10GA BLK
RED/BLK
6 5 4 3
12 V HEADLAMP CUTOFF RELAY A/C JCT. BOX
#21 10GA BLU/WHT
7 8 1 2
RED/BLK
DIODE 19-11-303
15 10GA BLK
15A CRT BRKR. A/C BOX 7C-13-127
HARNESS 7G-12-103
BATTERY DISCONNECT SWITCH
+ 24V
12V
BATTERY BUS BAR 24V DC
30A
10A
#15
15A
3A
ROAD LIGHT
*15P-RD/BL-14GA
CLEARANCE LAMP SWITCH
#4P-BN-16GA (15A-RD-12GA)
#4B-BK-18GA
HEADLIGHT SWITCH
DRIVERS SWITCH PANEL
(15-RD/RD-12
(*15P-RD-120
20A

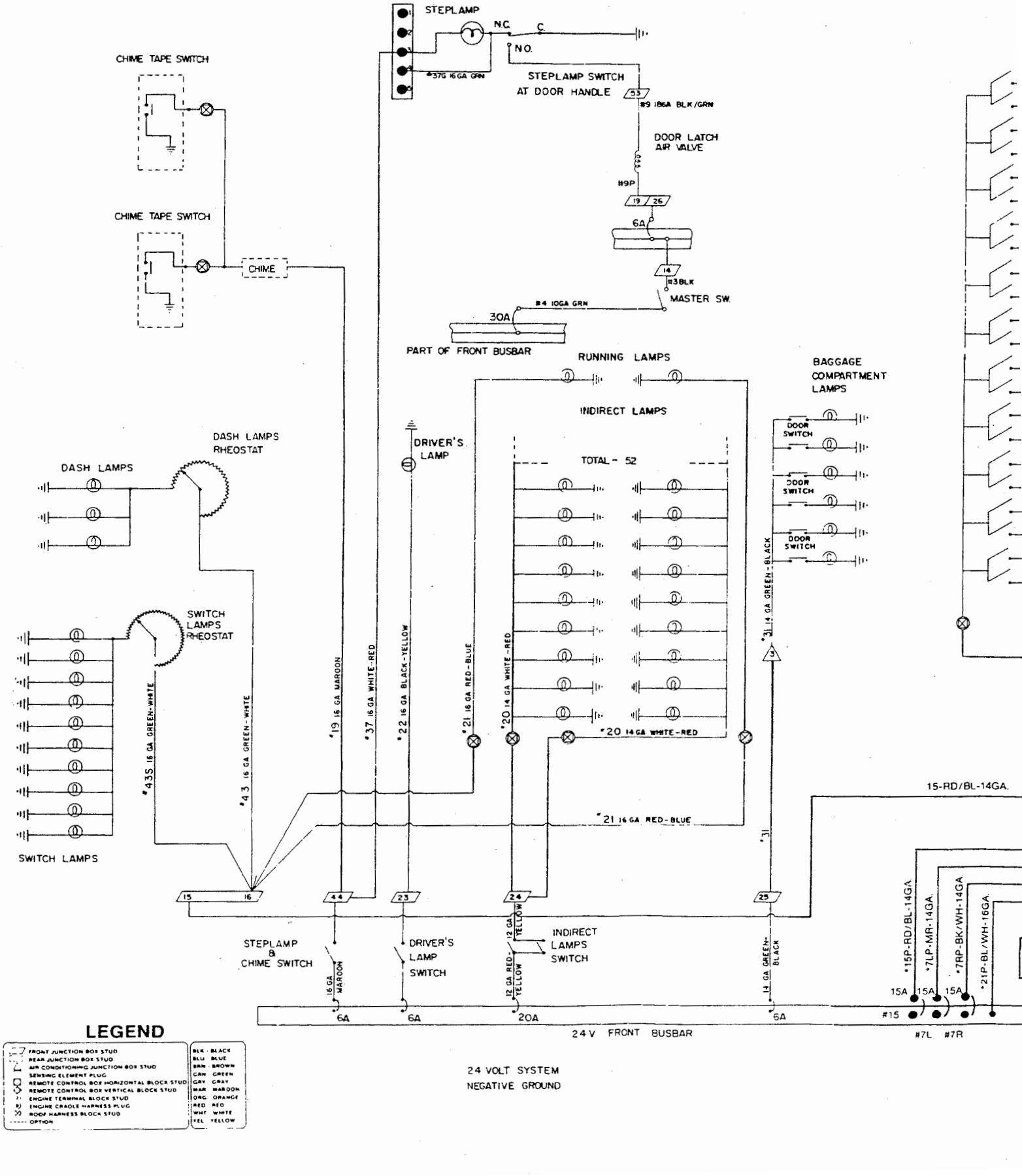
LEGEND

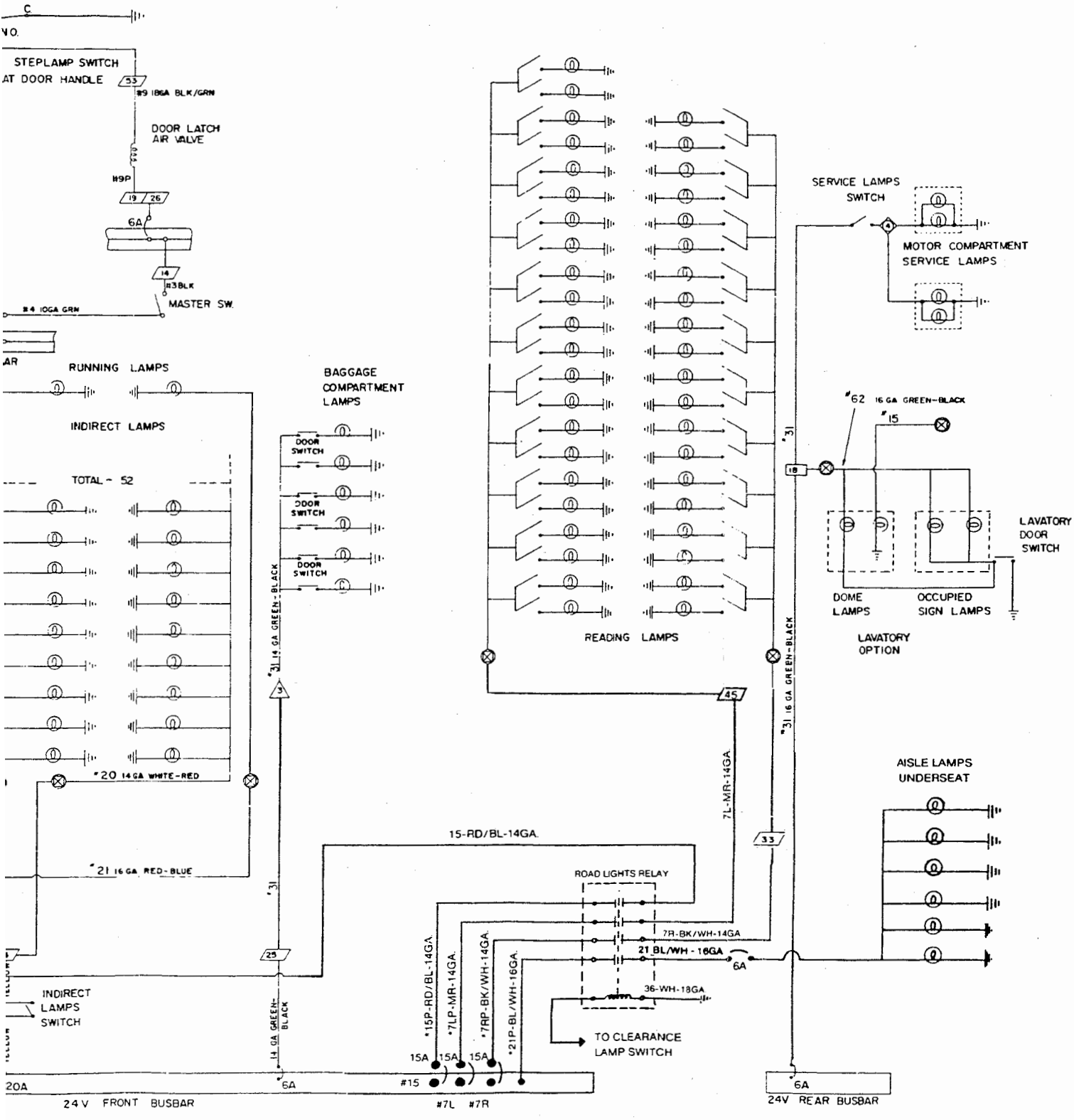
- FRONT JUNCTION BOX STUD
- REAR JUNCTION BOX STUD
- AIR CONDITIONING JUNCTION BOX STUD
- SENSING ELEMENT PLUG
- REMOTE CONTROL BOX HORIZONTAL BLOCK STUD
- REMOTE CONTROL BOX VERTICAL BLOCK STUD
- (2) ENGINE TERMINAL BLOCK STUD
- (B) ENGINE CRADLE HARNESS PLUG
- ROOF HARNESS BLOCK STUD
- ---- OPTION

BLK	- BLACK
BLU	- BLUE
BRN	- BROWN
GRN	- GREEN
GRY	- GRAY
MAR	- MAROON
ORG	- ORANGE
RED	- RED
WHT	- WHITE
YEL	- YELLOW

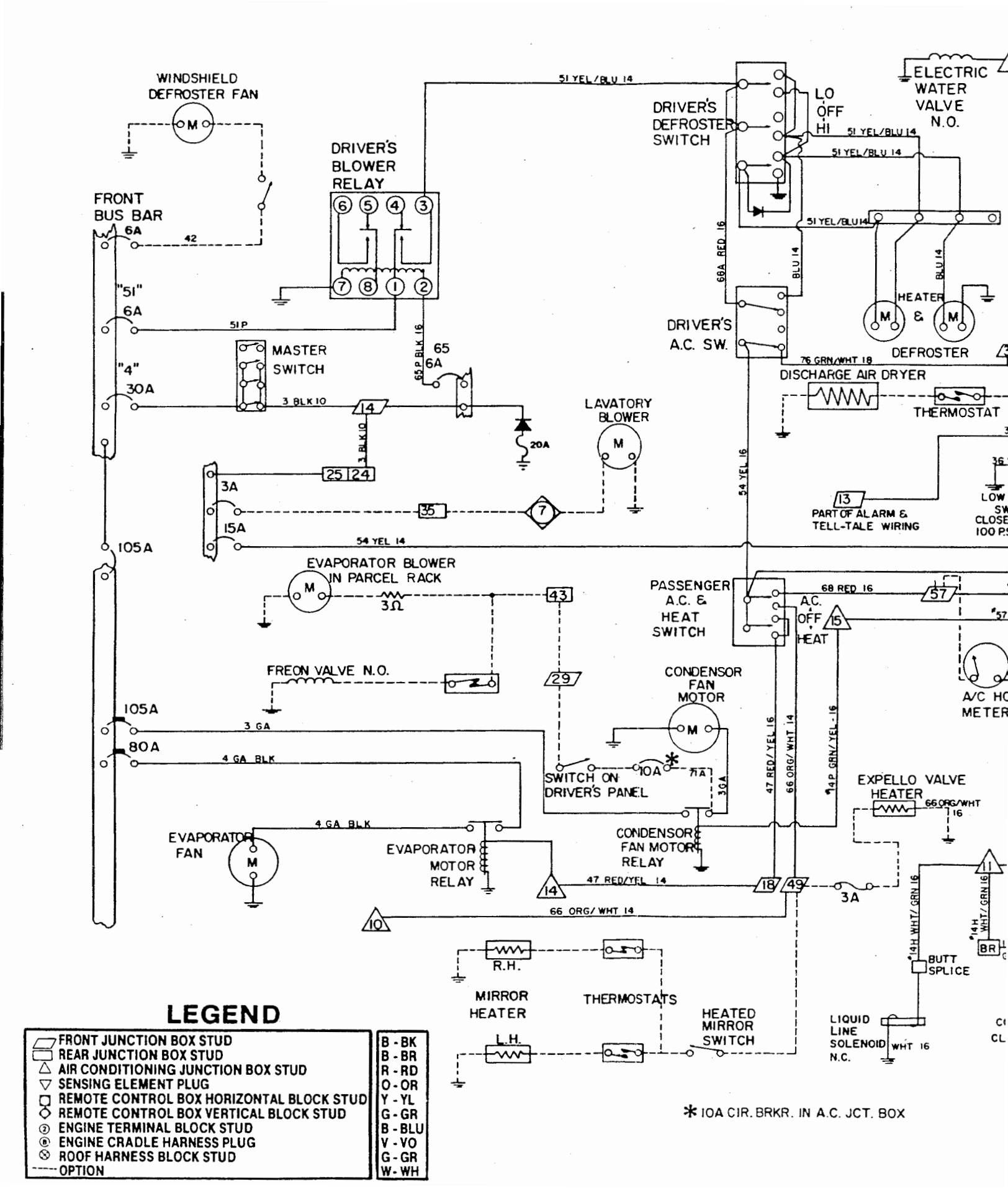


EXTERIOR LIGHTING
MC-9
DATE: JANUARY 1989


STEPLAMP
N.C.
C
N.O.
37G 16 GA GRN
STEPLAMP SWITCH AT DOOR HANDLE
53
#9 18GA BLK/GRN
DOOR LATCH AIR VALVE
#9P
19
26
6A
14
#3 BLK
MASTER SW.
#4 10GA GRN
30A
PART OF FRONT BUSBAR
CHIME TAPE SWITCH
CHIME TAPE SWITCH
CHIME
RUNNING LAMPS
INDIRECT LAMPS
TOTAL - 52
BAGGAGE COMPARTMENT LAMPS
DOOR SWITCH
DOOR SWITCH
DOOR SWITCH
DRIVER'S LAMP
DASH LAMPS
DASH LAMPS RHEOSTAT
SWITCH LAMPS RHEOSTAT
SWITCH LAMPS
*19 16 GA MAROON
*37 16 GA WHITE-RED
*22 16 GA BLACK-YELLOW
*21 16 GA RED-BLUE
*20 14 GA WHITE-RED
*20 14 GA WHITE-RED
*3L 14 GA GREEN-BLACK
*43S 16 GA GREEN-WHITE
*43 16 GA GREEN-WHITE
*21 16 GA RED-BLUE
*31
15-RD/BL-14GA.
15
16
44
23
24
25
STEPLAMP & CHIME SWITCH
16 GA MAROON
DRIVER'S LAMP SWITCH
12 GA YELLOW
12 GA RED-YELLOW
INDIRECT LAMPS SWITCH
14 GA GREEN-BLACK
*15P-RD/BL-14GA.
*7LP-MR-14GA.
*7RP-BK/WH-14GA.
*21P-BL/WH-16GA.
15A
15A
15A
6A
6A
20A
6A
#15
#7L
#7R
24 V FRONT BUSBAR
24 VOLT SYSTEM
NEGATIVE GROUND
LEGEND
FRONT JUNCTION BOX STUD
REAR JUNCTION BOX STUD
AIR CONDITIONING JUNCTION BOX STUD
SENSING ELEMENT PLUG
REMOTE CONTROL BOX HORIZONTAL BLOCK STUD
REMOTE CONTROL BOX VERTICAL BLOCK STUD
ENGINE TERMINAL BLOCK STUD
ENGINE CRADLE HARNESS PLUG
ROOF HARNESS BLOCK STUD
OPTION
BLK - BLACK
BLU - BLUE
BRN - BROWN
GRN - GREEN
GRY - GRAY
MAR - MAROON
ORG - ORANGE
RED - RED
WHT - WHITE
YEL - YELLOW

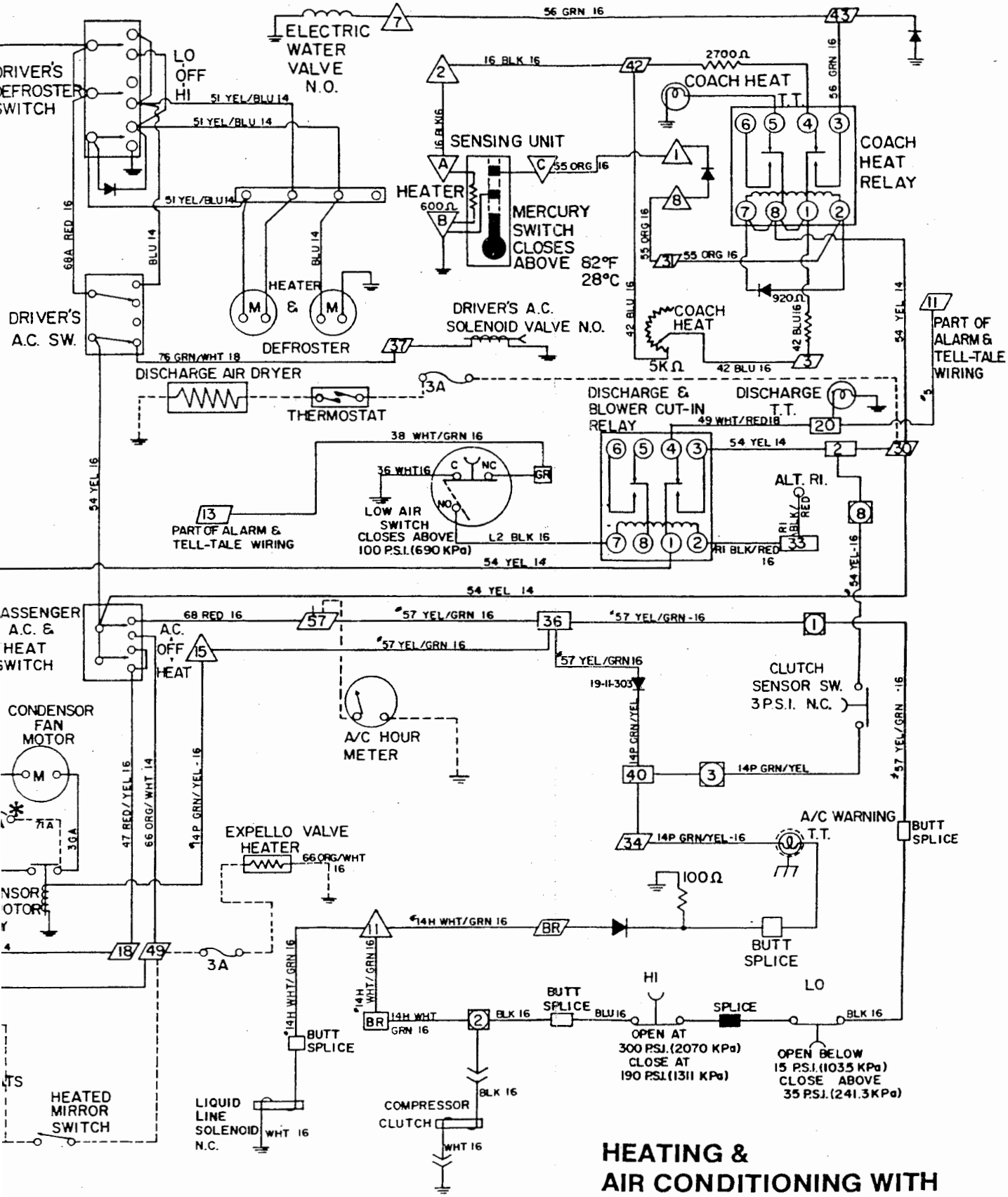


INTERIOR LIGHTING
MC-9
DATE: JAN. 1989



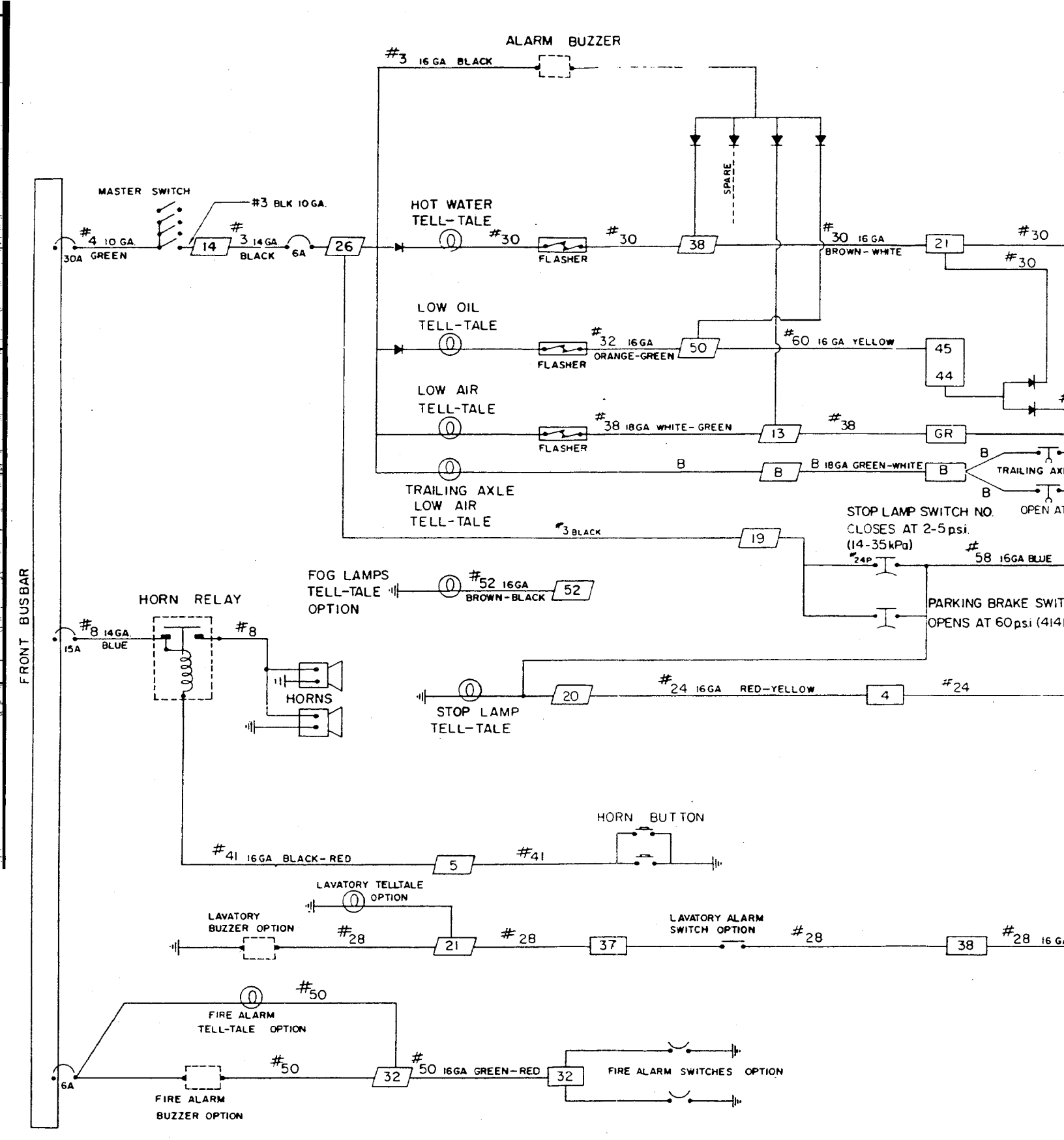
LEGEND

FRONT JUNCTION BOX STUD	B - BK
REAR JUNCTION BOX STUD	B - BR
AIR CONDITIONING JUNCTION BOX STUD	R - RD
SENSING ELEMENT PLUG	O - OR
REMOTE CONTROL BOX HORIZONTAL BLOCK STUD	Y - YL
REMOTE CONTROL BOX VERTICAL BLOCK STUD	G - GR
ENGINE TERMINAL BLOCK STUD	B - BLU
ENGINE CRADLE HARNESS PLUG	V - VO
ROOF HARNESS BLOCK STUD	G - GR
OPTION	W - WH



* 10A CIR. BRKR. IN A.C. JCT. BOX

HEATING & AIR CONDITIONING WITH 05G COMPRESSOR
MODEL: MC-9
DATE: JAN., 1989

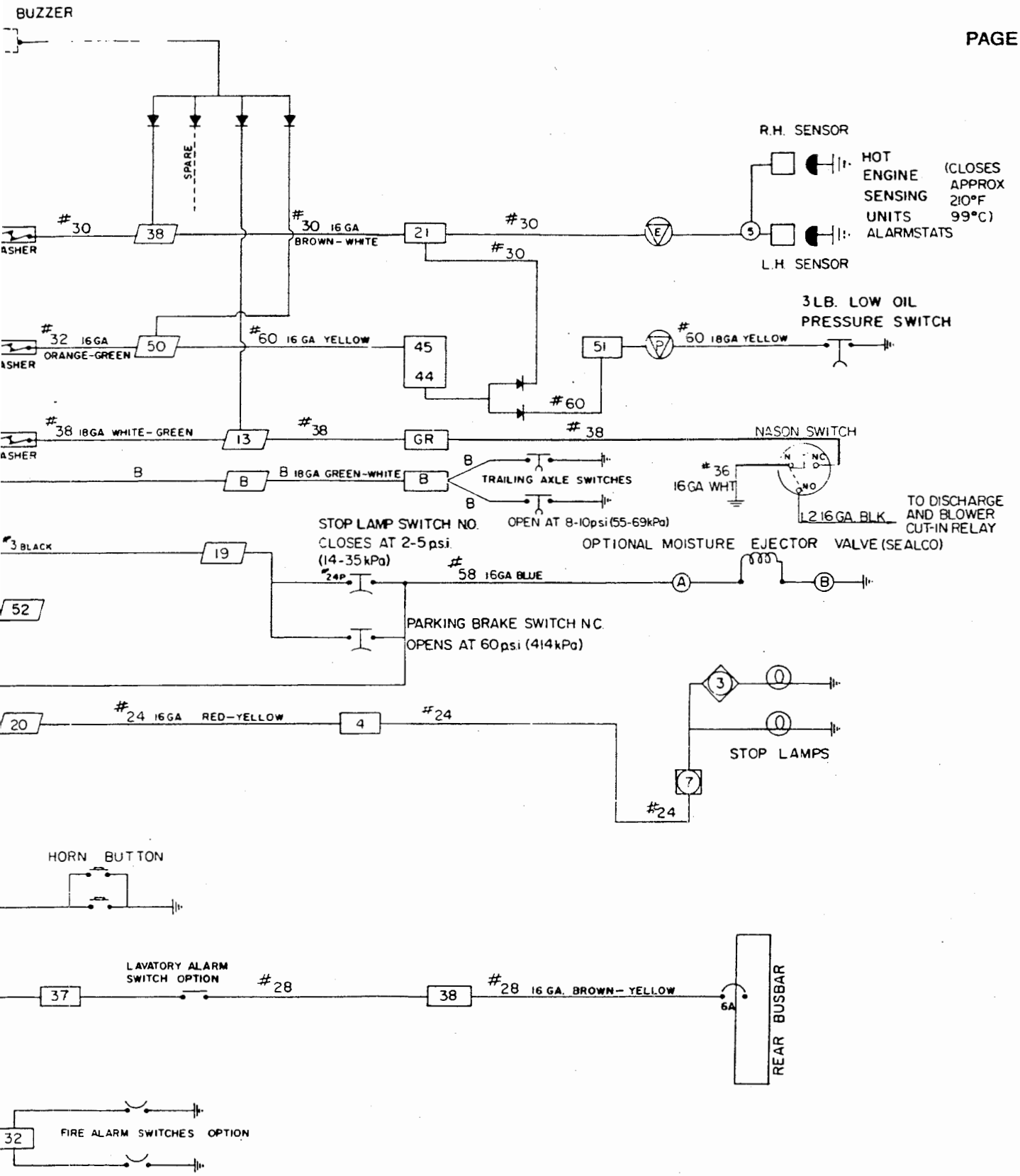


LEGEND

- FRONT JUNCTION BOX STUD
- REAR JUNCTION BOX STUD
- AIR CONDITIONING JUNCTION BOX STUD
- SENSING ELEMENT PLUG
- REMOTE CONTROL BOX HORIZONTAL BLOCK STUD
- REMOTE CONTROL BOX VERTICAL BLOCK STUD
- ENGINE TERMINAL BLOCK STUD
- ENGINE CRADLE HARNESS PLUG
- ROOF HARNESS BLOCK STUD
- ----- OPTION

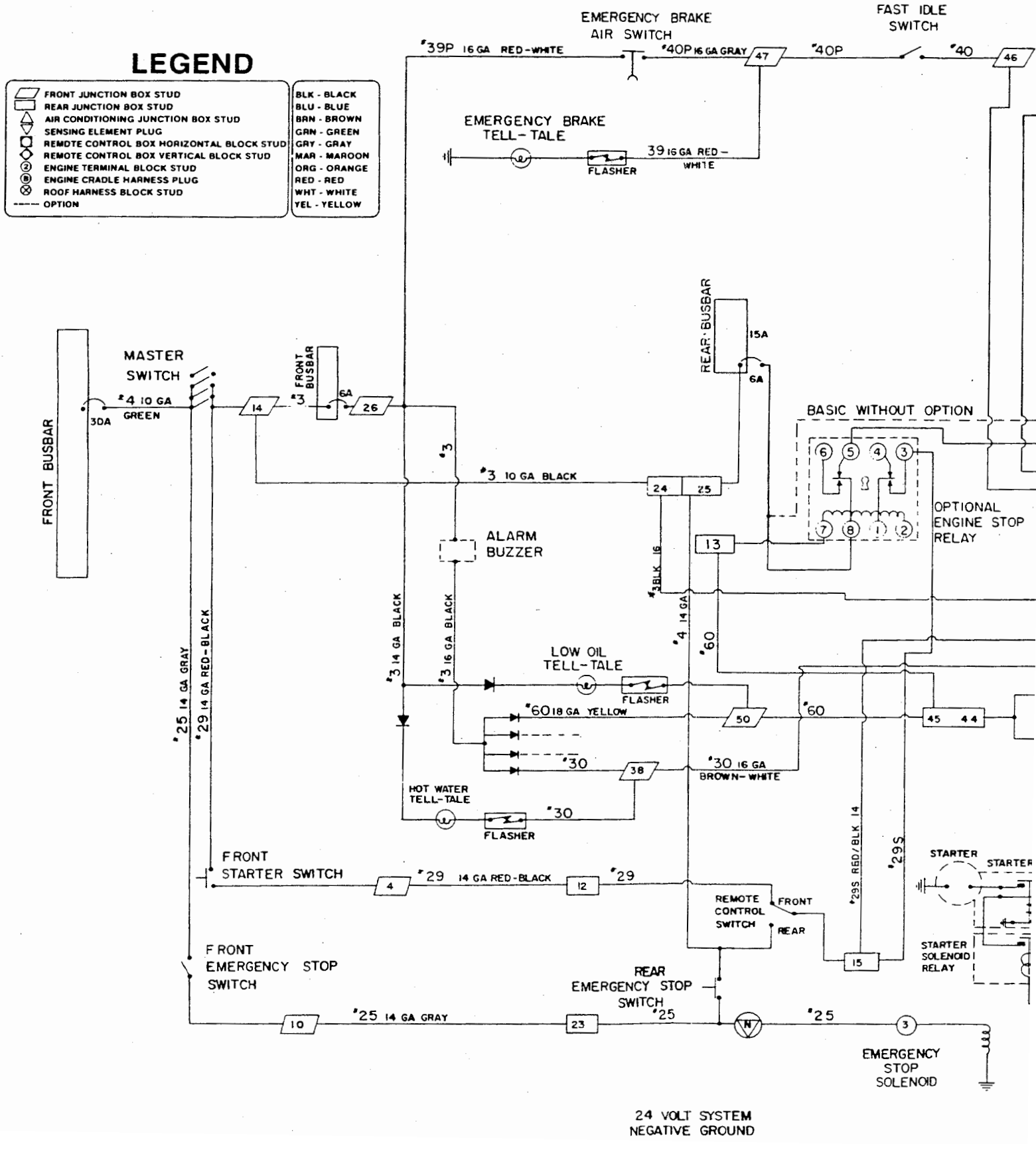
BLK - BLACK
BLU - BLUE
BRN - BROWN
GRN - GREEN
GRY - GRAY
MAR - MAROON
ORG - ORANGE
RED - RED
WHT - WHITE
YEL - YELLOW

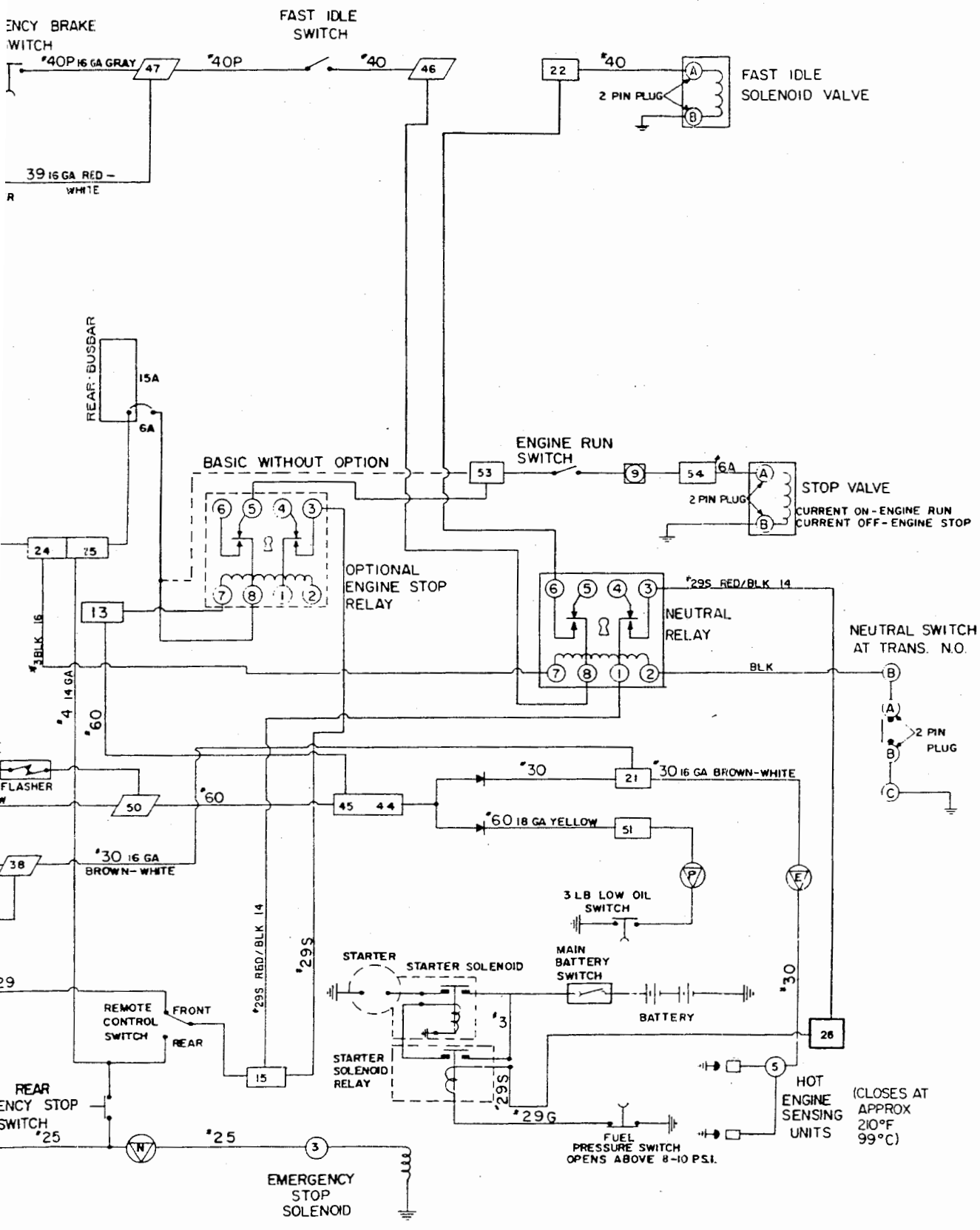
24 VOLT SYSTEM
NEGATIVE GROUND



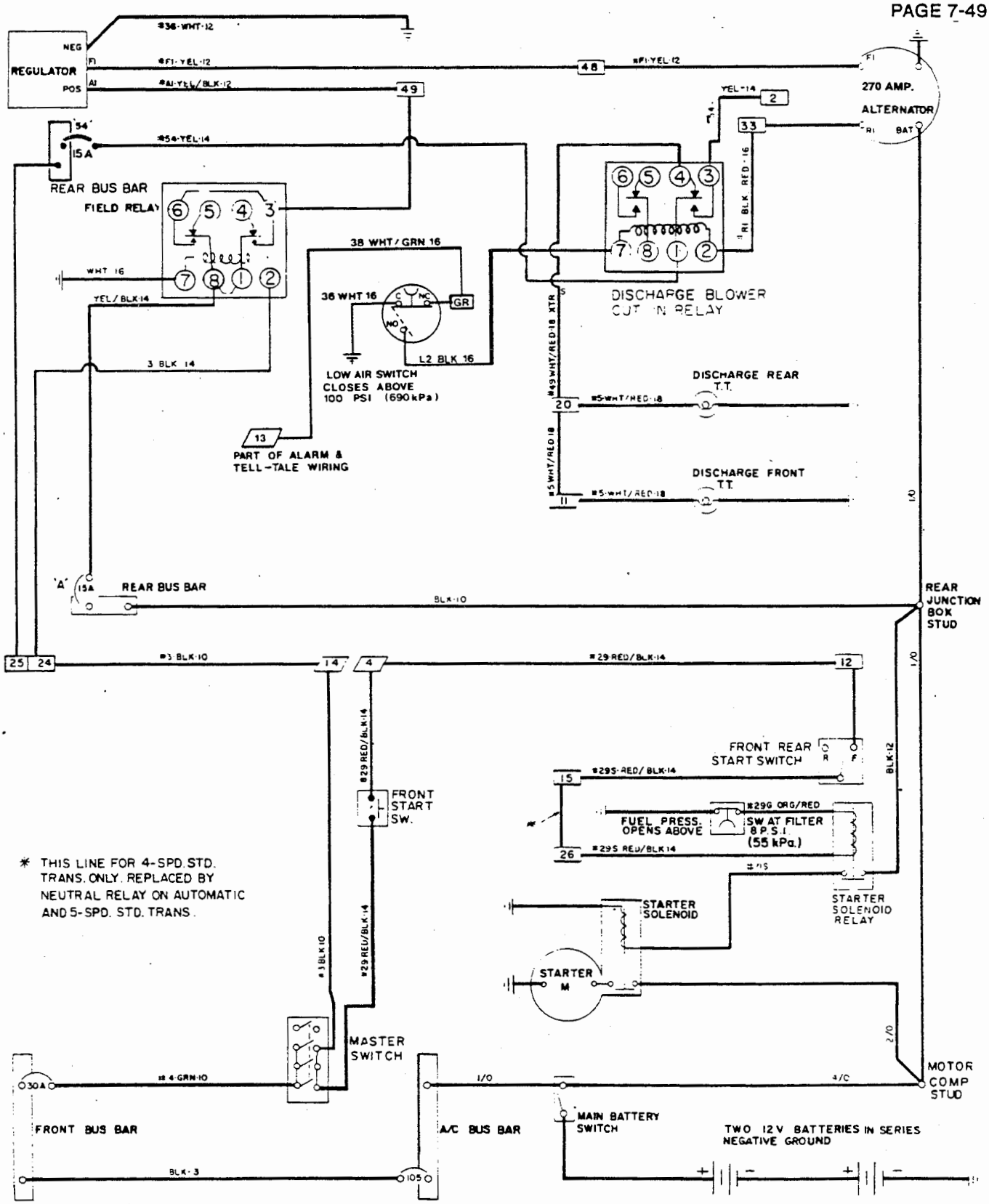
24 VOLT SYSTEM
NEGATIVE GROUND

ALARM & TELL-TALE WIRING
MODEL: MC-9
DATE: JAN. 1989


LEGEND
FRONT JUNCTION BOX STUD
REAR JUNCTION BOX STUD
AIR CONDITIONING JUNCTION BOX STUD
SENSING ELEMENT PLUG
REMOTE CONTROL BOX HORIZONTAL BLOCK STUD
REMOTE CONTROL BOX VERTICAL BLOCK STUD
ENGINE TERMINAL BLOCK STUD
ENGINE CRADLE HARNESS PLUG
ROOF HARNESS BLOCK STUD
OPTION
BLK - BLACK
BLU - BLUE
BRN - BROWN
GRN - GREEN
GRY - GRAY
MAR - MAROON
ORG - ORANGE
RED - RED
WHT - WHITE
YEL - YELLOW
EMERGENCY BRAKE AIR SWITCH
FAST IDLE SWITCH
*39P 16 GA RED-WHITE
*40P 16 GA GRAY
47
*40P
*40
46
EMERGENCY BRAKE TELL-TALE
FLASHER
39 16 GA RED-WHITE
REAR BUSBAR
15A
6A
BASIC WITHOUT OPTION
OPTIONAL ENGINE STOP RELAY
MASTER SWITCH
FRONT BUSBAR
*4 10 GA GREEN
30A
14
*3
FRONT BUSBAR
6A
26
*3
*3 10 GA BLACK
24
25
ALARM BUZZER
13
*3 BLK 16
*4 14 GA
*60
*3 14 GA BLACK
*3 16 GA BLACK
LOW OIL TELL-TALE
FLASHER
*60 18 GA YELLOW
50
*60
45
44
*25 14 GA GRAY
*29 14 GA RED-BLACK
*30
38
*30 16 GA BROWN-WHITE
HOT WATER TELL-TALE
FLASHER
*30
FRONT STARTER SWITCH
4
*29 14 GA RED-BLACK
12
*29
REMOTE CONTROL SWITCH
FRONT
REAR
*29S RED/BLK 14
*29S
STARTER
STARTER
STARTER SOLENOID RELAY
15
FRONT EMERGENCY STOP SWITCH
REAR EMERGENCY STOP SWITCH
*25
10
*25 14 GA GRAY
23
*25
3
EMERGENCY STOP SOLENOID
24 VOLT SYSTEM
NEGATIVE GROUND



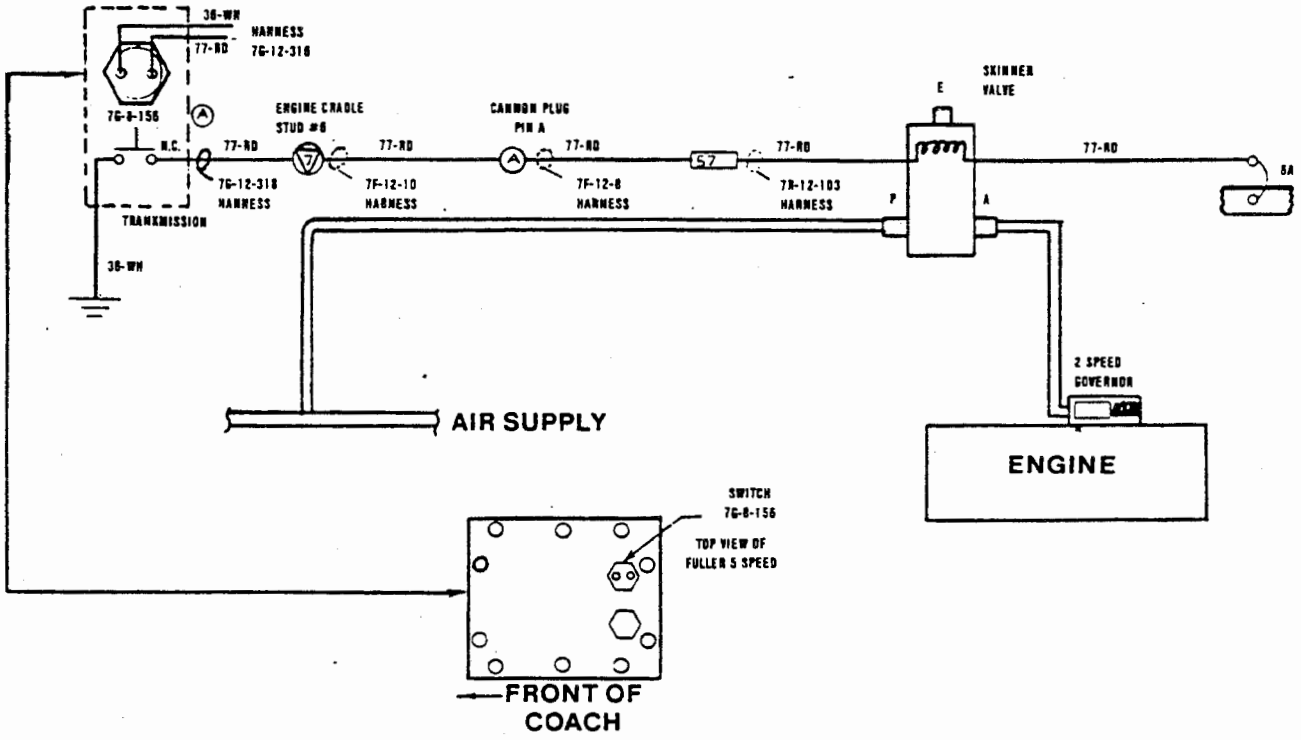
MOTOR CONTROL WIRING
MODEL: MC-9
EFFECTIVE UNIT NO. 36355
DATE: JAN. 1989



LEGEND

FRONT JUNCTION BOX STUD	BLK - BLACK
REAR JUNCTION BOX STUD	BLU - BLUE
AIR CONDITIONING JUNCTION BOX STUD	BRN - BROWN
SENSING ELEMENT PLUG	GRN - GREEN
REMOTE CONTROL BOX HORIZONTAL BLOCK STUD	GRY - GRAY
REMOTE CONTROL BOX VERTICAL BLOCK STUD	MAR - MAROON
(2) ENGINE TERMINAL BLOCK STUD	ORG - ORANGE
(B) ENGINE CRADLE HARNESS PLUG	RED - RED
(X) ROOF HARNESS BLOCK STUD	WHT - WHITE
----- OPTION	YEL - YELLOW

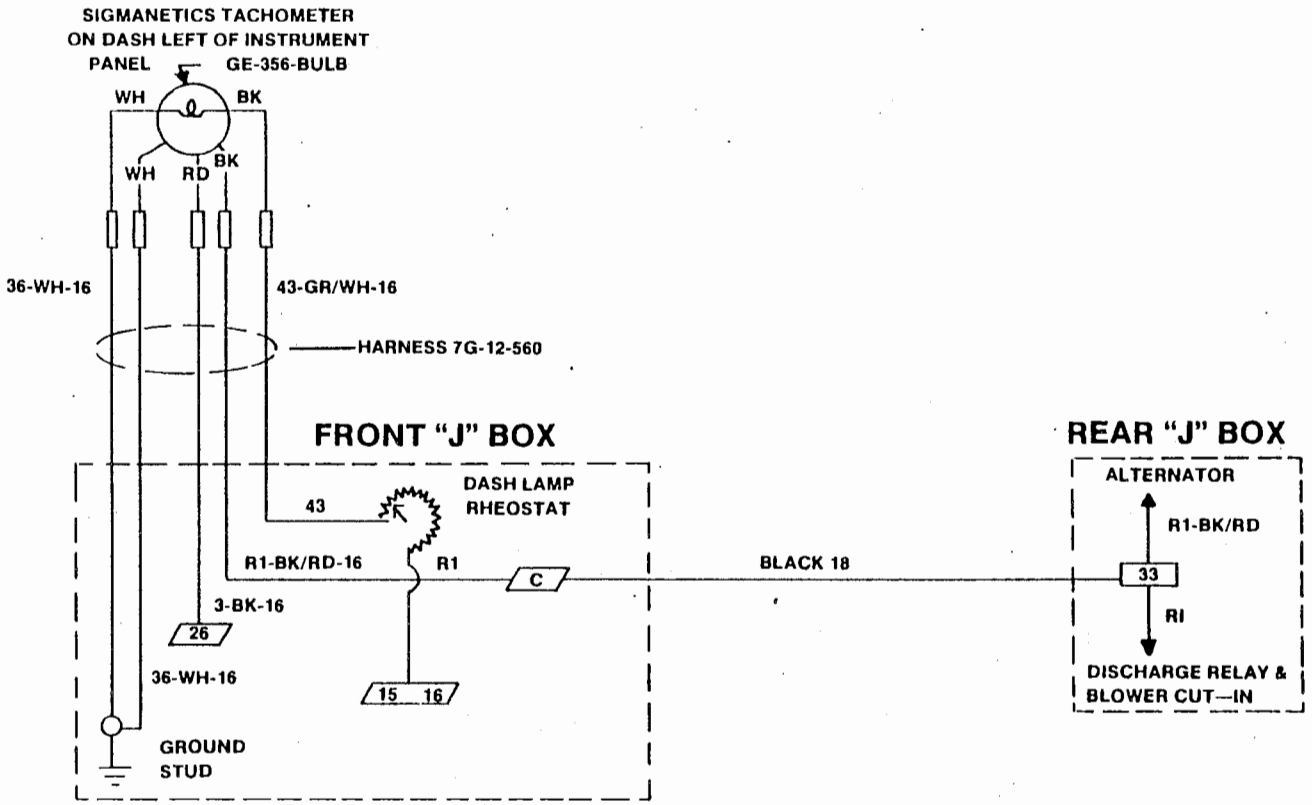
CHARGING & STARTING
MODEL: MC-9
DATE: JAN. 1989



LEGEND

FRONT JUNCTION BOX STUD	BK - BLACK
REAR JUNCTION BOX STUD	BR - BROWN
AIR CONDITIONING JUNCTION BOX STUD	RD - RED
SENSING ELEMENT PLUG	OR - ORANGE
REMOTE CONTROL BOX HORIZONTAL BLOCK STUD	YL - YELLOW
REMOTE CONTROL BOX VERTICAL BLOCK STUD	GR - GREEN
ENGINE TERMINAL BLOCK STUD	BL - BLUE
ENGINE CRADLE HARNESS PLUG	VO - VIOLET
ROOF HARNESS BLOCK STUD	GY - GREY
OPTION	WH - WHITE

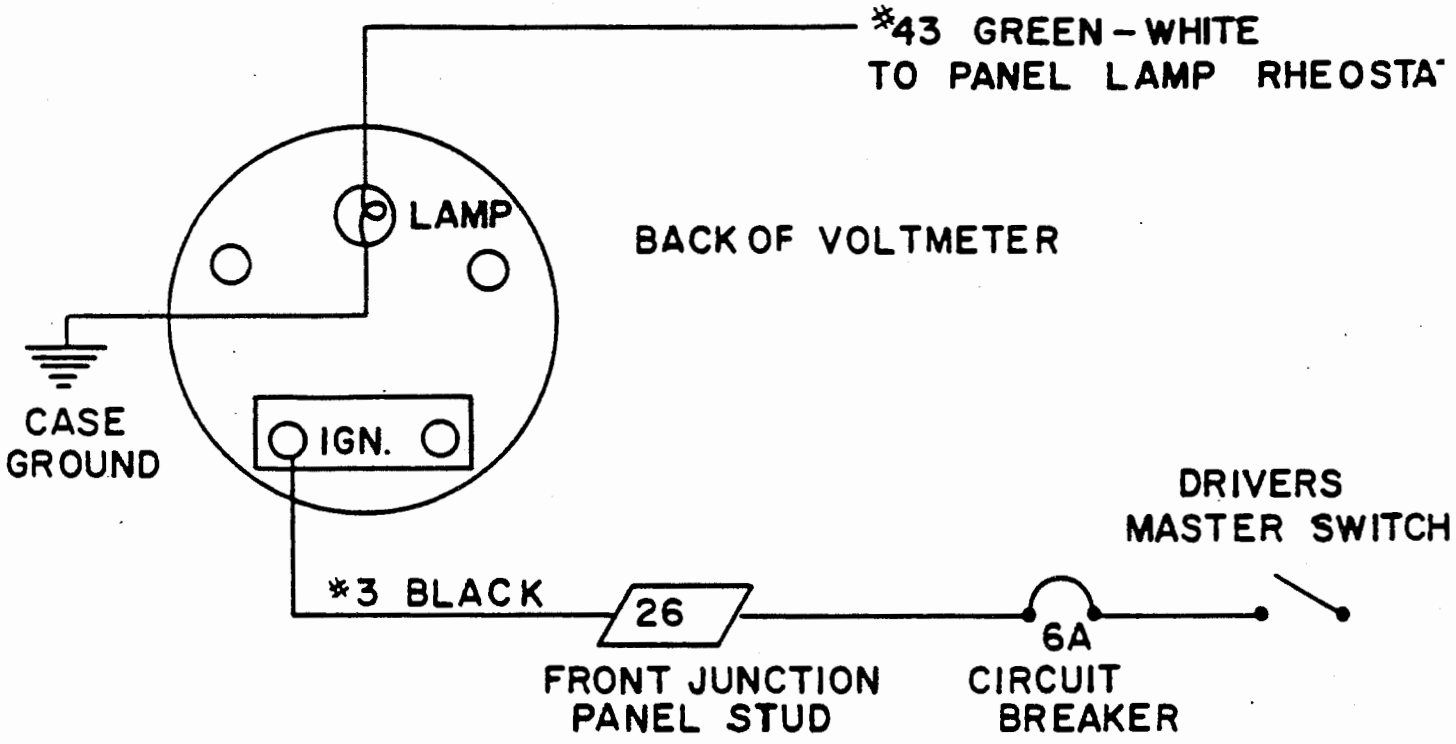
TWO-SPEED GOVERNOR
(WITH FULLER 5 SPEED TRANS)
MODEL: MC-9
DATE: JAN. 1989



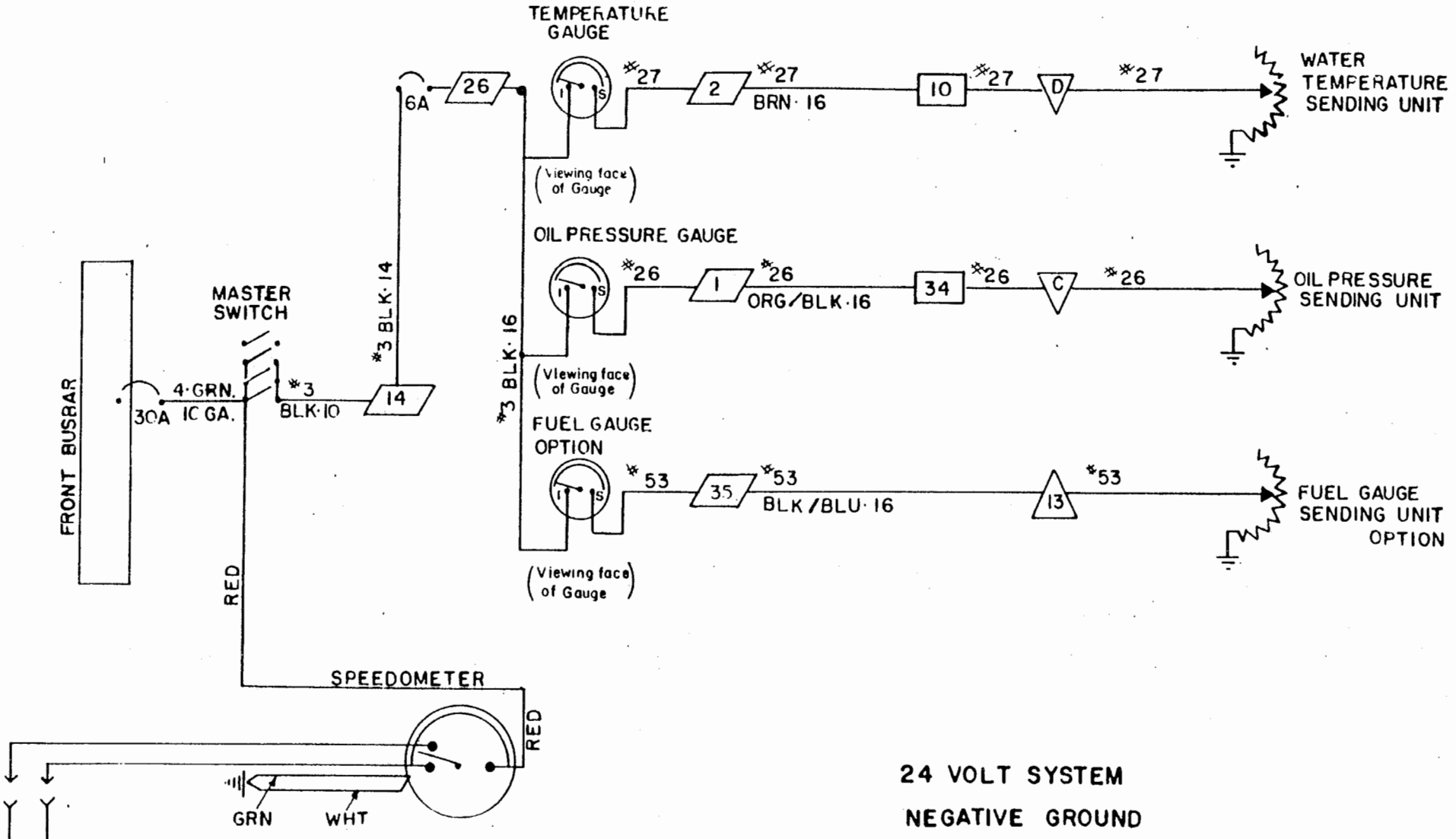
LEGEND

FRONT JUNCTION BOX STUD	B - BK
REAR JUNCTION BOX STUD	B - BR
AIR CONDITIONING JUNCTION BOX STUD	R - RD
SENSING ELEMENT PLUG	O - OR
REMOTE CONTROL BOX HORIZONTAL BLOCK STUD	Y - YL
REMOTE CONTROL BOX VERTICAL BLOCK STUD	G - GR
ENGINE TERMINAL BLOCK STUD	B - BLU
ENGINE CRADLE HARNESS PLUG	V - VO
ROOF HARNESS BLOCK STUD	G - GR
----- OPTION	W - WH

WIRING DIAGRAM
SIGMANETICS TACHOMETER
MODEL: MC-9
DATE JAN. 1989



VOLTMETER INSTALLATION
(24-VOLT-NEGATIVE GROUND)
MODEL: MC-9
DATE: JAN. 1989



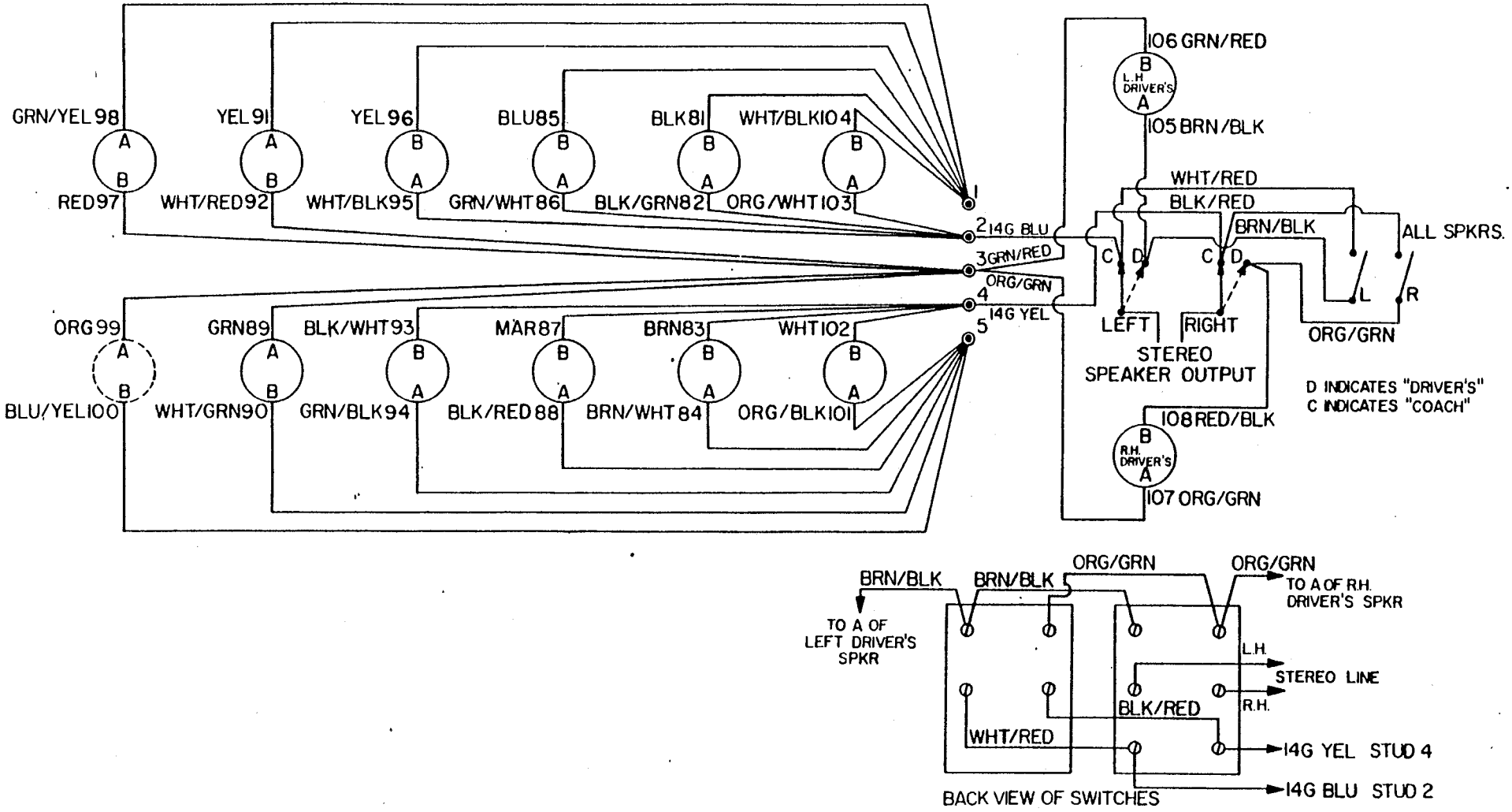
24 VOLT SYSTEM

NEGATIVE GROUND

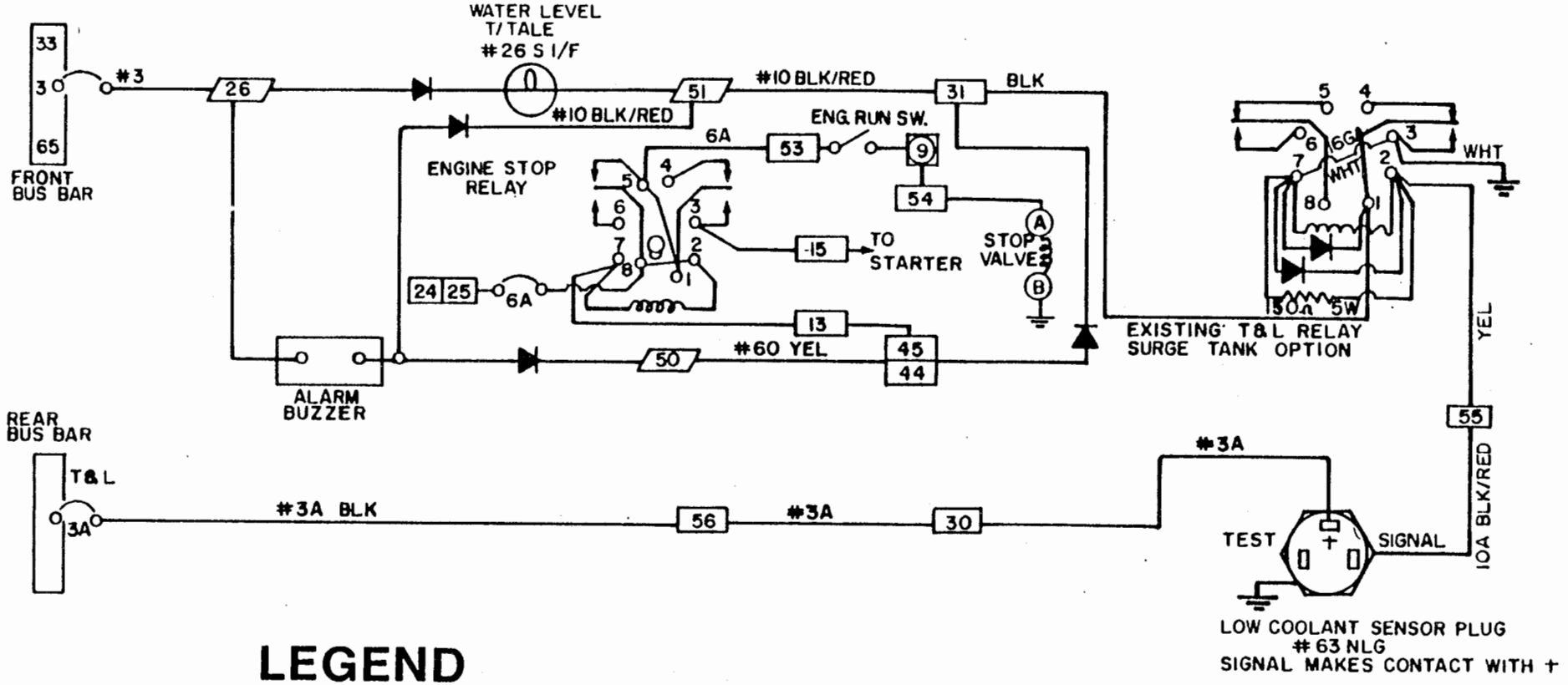
LEGEND

FRONT JUNCTION BOX STUD	BLK - BLACK
REAR JUNCTION BOX STUD	BLU - BLUE
AIR CONDITIONING JUNCTION BOX STUD	BRN - BROWN
SENSING ELEMENT PLUG	GRN - GREEN
REMOTE CONTROL BOX HORIZONTAL BLOCK STUD	GRY - GRAY
REMOTE CONTROL BOX VERTICAL BLOCK STUD	MAR - MAROON
ENGINE TERMINAL BLOCK STUD	ORG - ORANGE
ENGINE CRADLE HARNESS PLUG	RED - RED
ROOF HARNESS BLOCK STUD	WHT - WHITE
OPTION	YEL - YELLOW

STEWART WARNER GAUGES
INSTRUMENT WIRING
MODEL: MC-9
DATE: JAN. 1989



STEREO SPEAKER DIAGRAM
WITH OPTIONAL DRIVER'S SPEAKERS
MODEL: MC-9
DATE: JAN. 1989

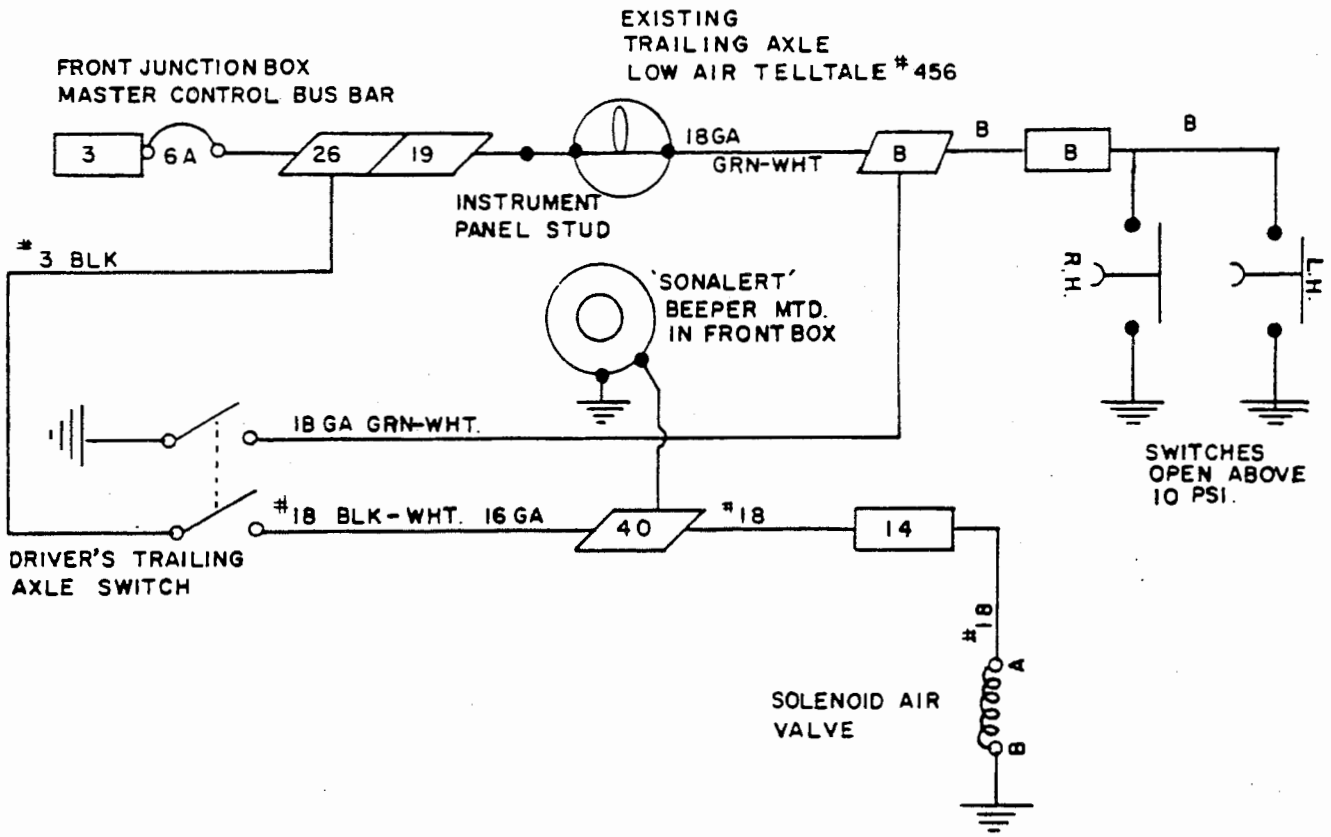


LEGEND

- FRONT JUNCTION BOX STUD
- REAR JUNCTION BOX STUD
- AIR CONDITIONING JUNCTION BOX STUD
- SENSING ELEMENT PLUG
- REMOTE CONTROL BOX HORIZONTAL BLOCK STUD
- REMOTE CONTROL BOX VERTICAL BLOCK STUD
- ENGINE TERMINAL BLOCK STUD
- ENGINE CRADLE HARNESS PLUG
- ROOF HARNESS BLOCK STUD
- ----- OPTION

BLK	BLACK
BLU	BLUE
BRN	BROWN
GRN	GREEN
GRY	GRAY
MAR	MAROON
ORG	ORANGE
RED	RED
WHT	WHITE
YEL	YELLOW

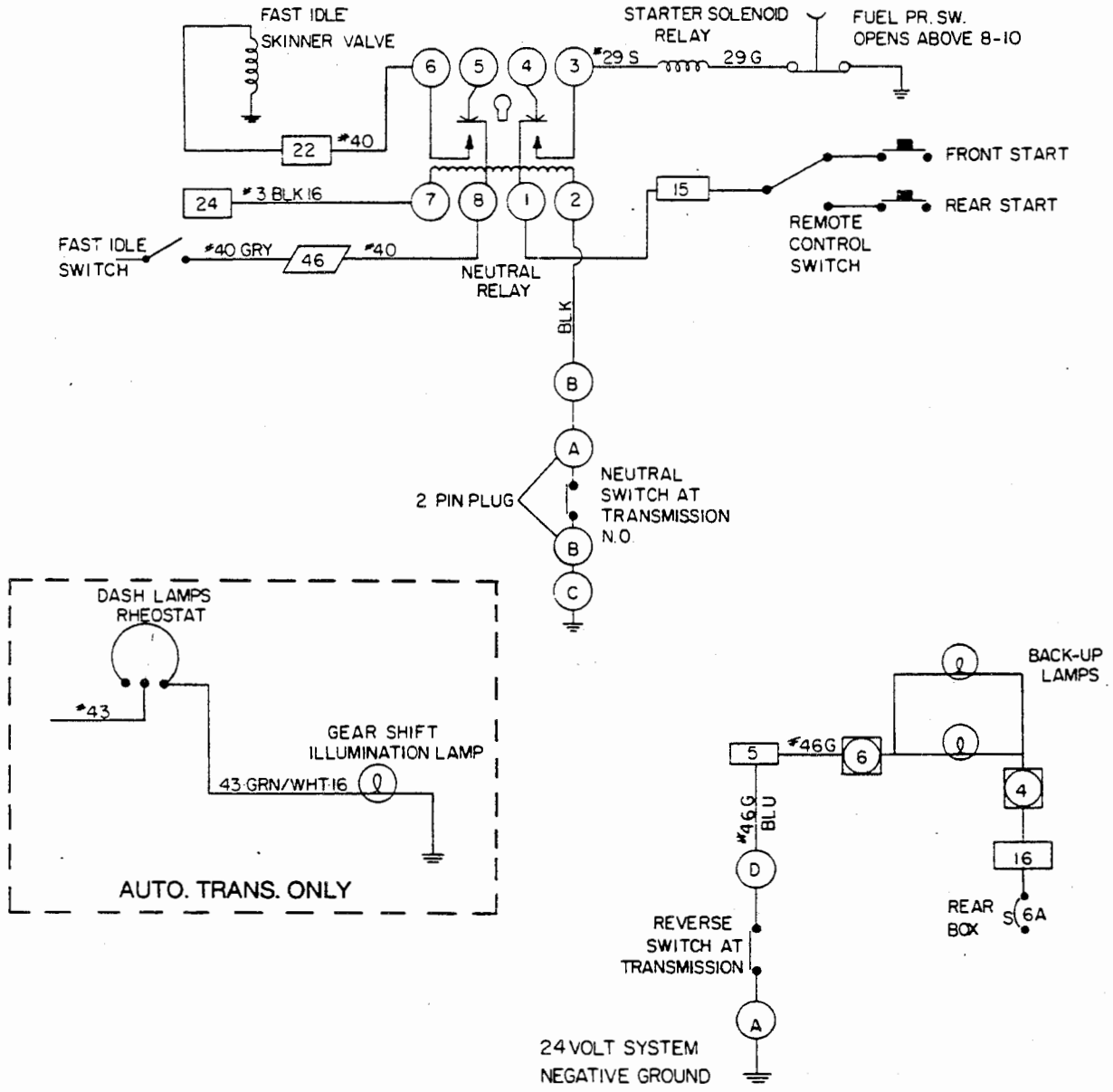
WIRING DIAGRAM
LOW COOLANT LEVEL - WARNING & SHUTDOWN OPTION
MODEL: MC-9
DATE: JAN 1989



LEGEND

FRONT JUNCTION BOX STUD	BLK - BLACK
REAR JUNCTION BOX STUD	BLU - BLUE
AIR CONDITIONING JUNCTION BOX STUD	BRN - BROWN
SENSING ELEMENT PLUG	GRN - GREEN
REMOTE CONTROL BOX HORIZONTAL BLOCK STUD	GRY - GRAY
REMOTE CONTROL BOX VERTICAL BLOCK STUD	MAR - MAROON
ENGINE TERMINAL BLOCK STUD	ORG - ORANGE
ENGINE CRADLE HARNESS PLUG	RED - RED
ROOF HARNESS BLOCK STUD	WHT - WHITE
----- OPTION	YEL - YELLOW

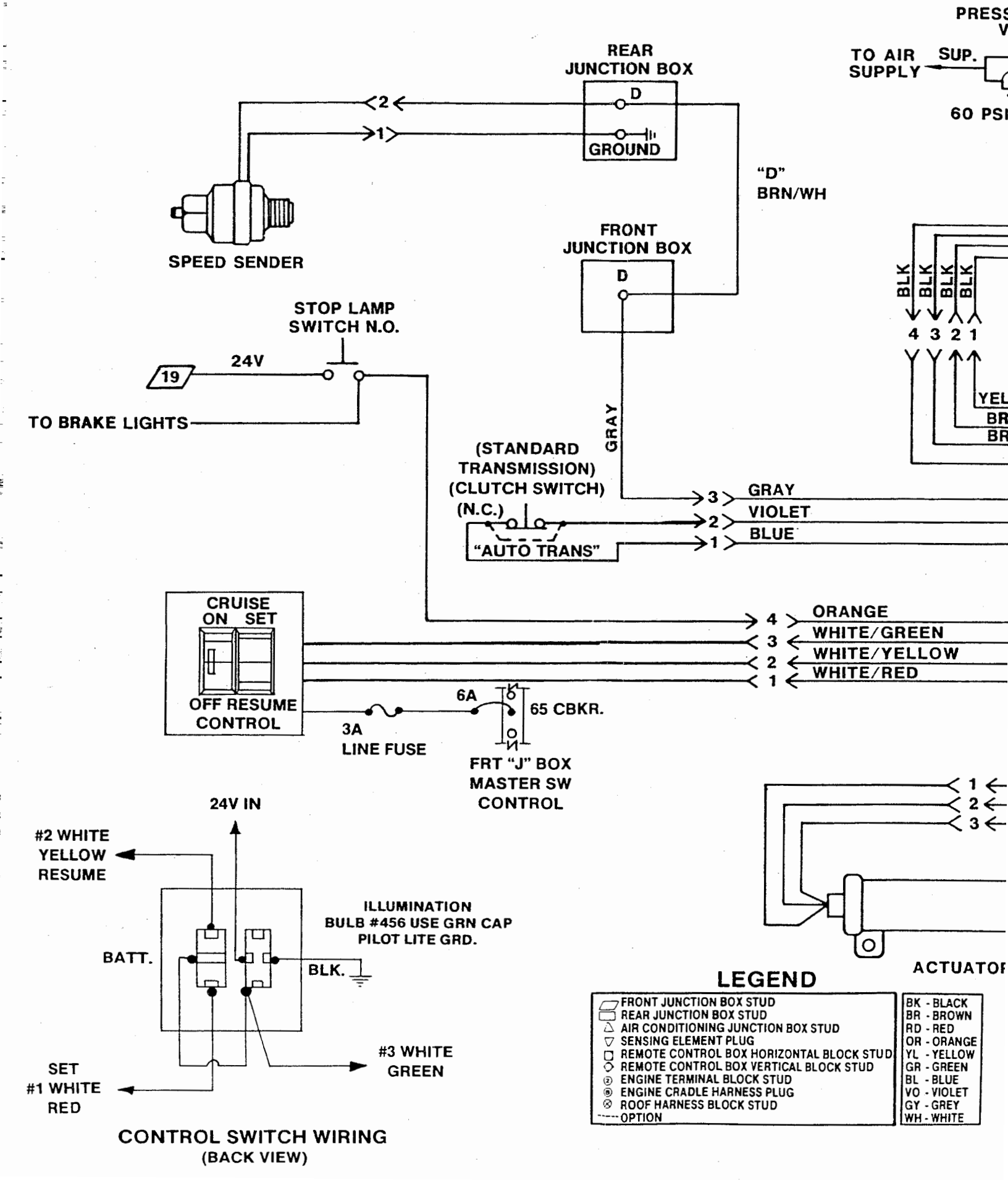
TRAILING AXLE UNLOADING WIRING DIAGRAM (OPTIONAL)
MODEL: MC-9
DATE: JAN. 1989



LEGEND

FRONT JUNCTION BOX STUD	BLK - BLACK
REAR JUNCTION BOX STUD	BLU - BLUE
AIR CONDITIONING JUNCTION BOX STUD	BRN - BROWN
SENSING ELEMENT PLUG	GRN - GREEN
REMOTE CONTROL BOX HORIZONTAL BLOCK STUD	GRY - GRAY
REMOTE CONTROL BOX VERTICAL BLOCK STUD	MAR - MAROON
ENGINE TERMINAL BLOCK STUD	ORG - ORANGE
ENGINE CRADLE HARNESS PLUG	RED - RED
ROOF HARNESS BLOCK STUD	WHT - WHITE
OPTION	YEL - YELLOW

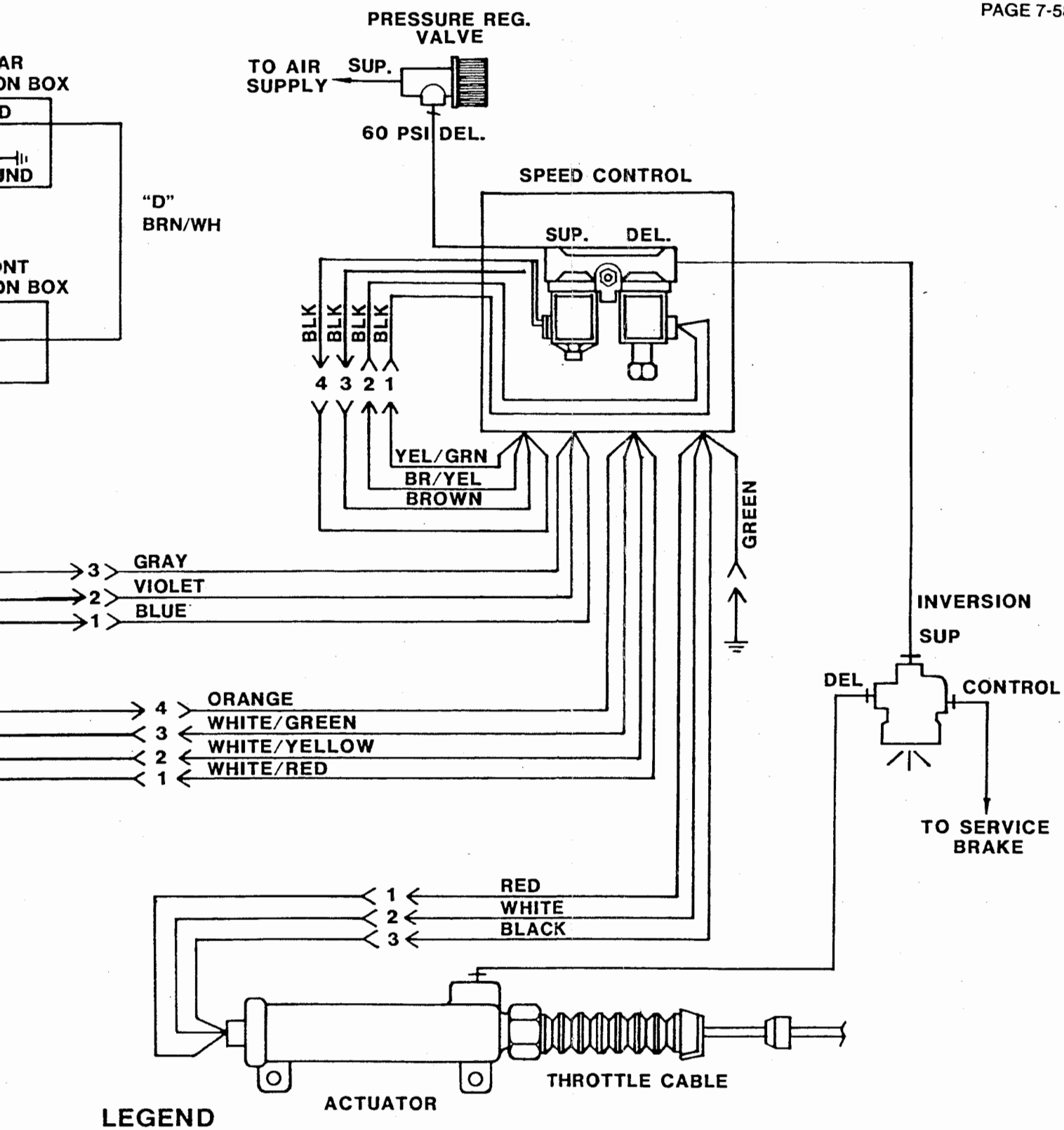
TRANSMISSION WIRING DIAGRAM
MODEL: MC-9
DATE: JAN. 1989



CONTROL SWITCH WIRING
(BACK VIEW)

LEGEND

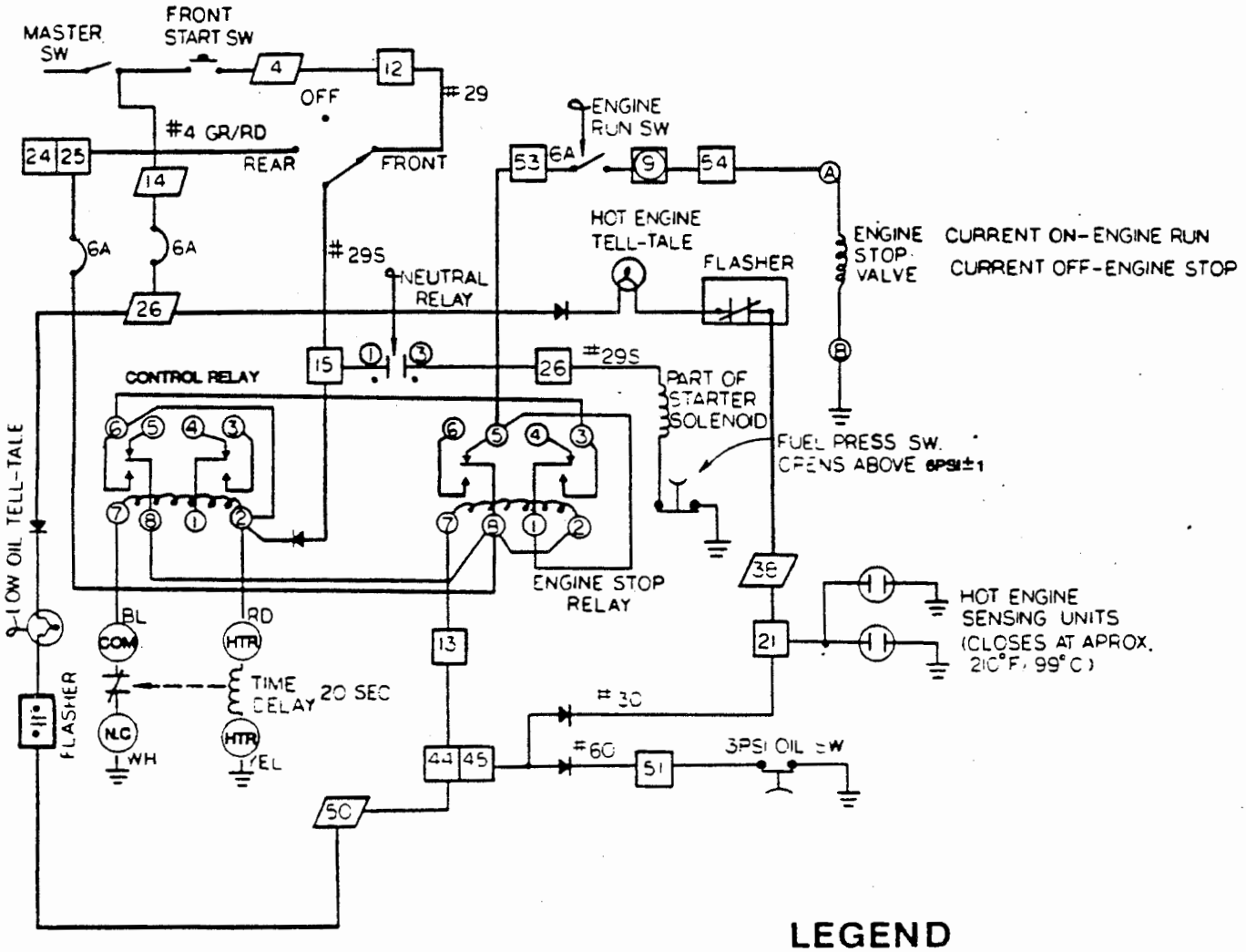
FRONT JUNCTION BOX STUD	BK - BLACK
REAR JUNCTION BOX STUD	BR - BROWN
AIR CONDITIONING JUNCTION BOX STUD	RD - RED
SENSING ELEMENT PLUG	OR - ORANGE
REMOTE CONTROL BOX HORIZONTAL BLOCK STUD	YL - YELLOW
REMOTE CONTROL BOX VERTICAL BLOCK STUD	GR - GREEN
ENGINE TERMINAL BLOCK STUD	BL - BLUE
ENGINE CRADLE HARNESS PLUG	VO - VIOLET
ROOF HARNESS BLOCK STUD	GY - GREY
OPTION	WH - WHITE



LEGEND

RONT JUNCTION BOX STUD	BK - BLACK
EAR JUNCTION BOX STUD	BR - BROWN
IR CONDITIONING JUNCTION BOX STUD	RD - RED
ENSING ELEMENT PLUG	OR - ORANGE
EMOTE CONTROL BOX HORIZONTAL BLOCK STUD	YL - YELLOW
EMOTE CONTROL BOX VERTICAL BLOCK STUD	GR - GREEN
NGINE TERMINAL BLOCK STUD	BL - BLUE
NGINE CRADLE HARNESS PLUG	VO - VIOLET
OOF HARNESS BLOCK STUD	GY - GREY
PTION	WH - WHITE

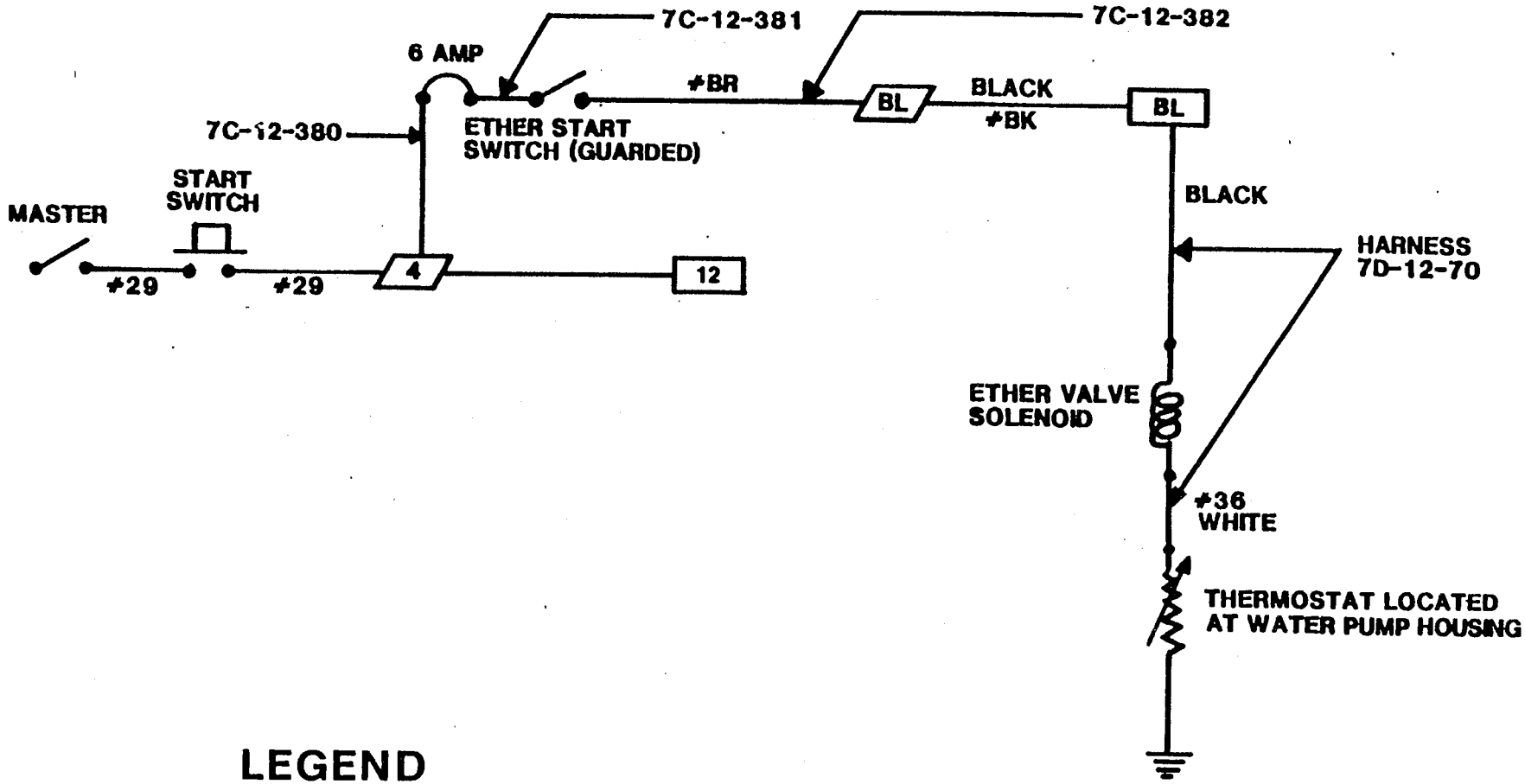
CRUISE CONTROL WIRING
MODEL: MC-9
DATE: JAN. 1989



LEGEND

FRONT JUNCTION BOX STUD	BK - BLACK
REAR JUNCTION BOX STUD	BR - BROWN
AIR CONDITIONING JUNCTION BOX STUD	RD - RED
SENSING ELEMENT PLUG	OR - ORANGE
REMOTE CONTROL BOX HORIZONTAL BLOCK STUD	YL - YELLOW
REMOTE CONTROL BOX VERTICAL BLOCK STUD	GR - GREEN
ENGINE TERMINAL BLOCK STUD	BL - BLUE
ENGINE CRADLE HARNESS PLUG	VO - VIOLET
ROOF HARNESS BLOCK STUD	GY - GREY
OPTION	WH - WHITE

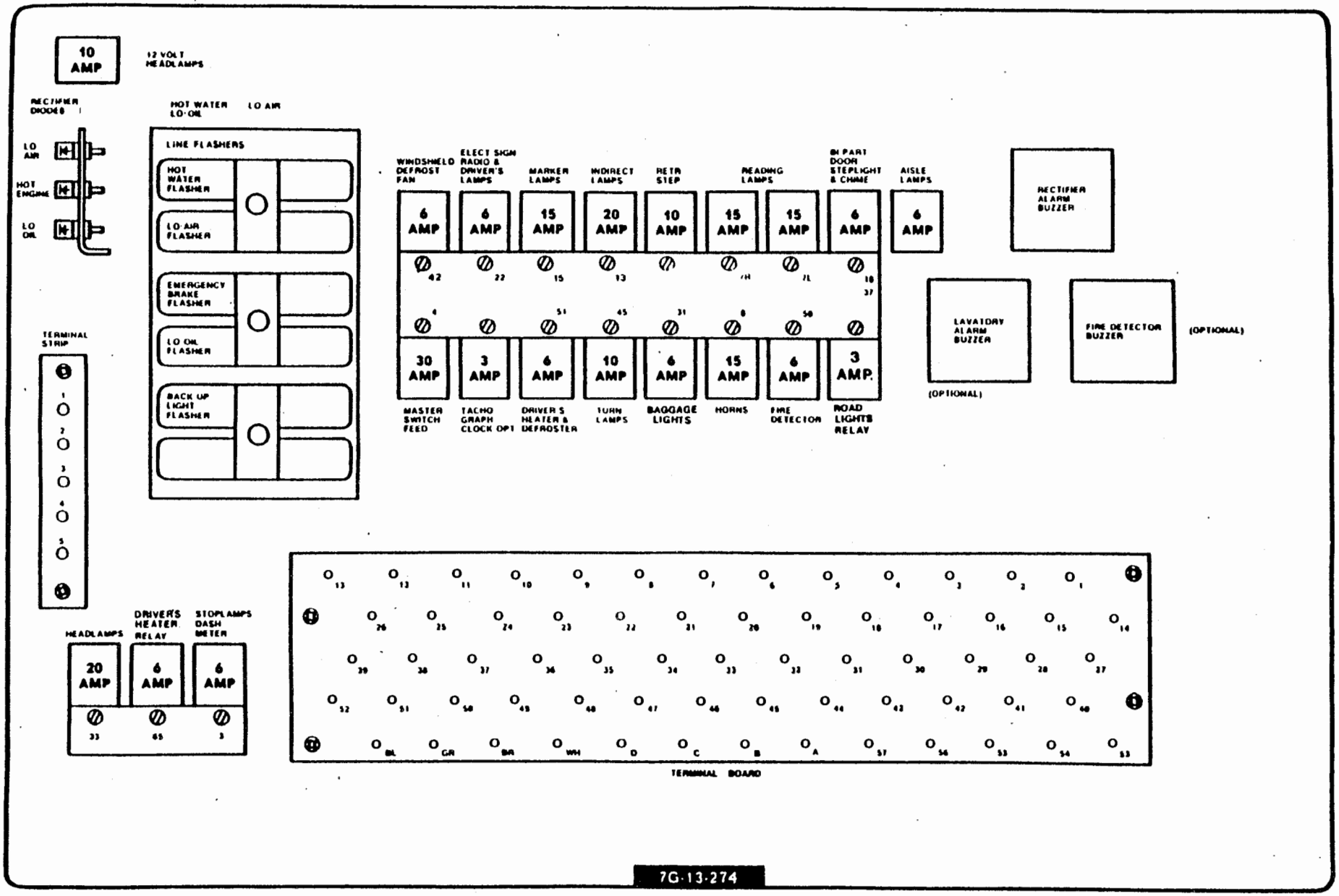
STARTING CIRCUIT WITH THERMAL TIME DELAY
MODEL: MC-9
DATE: JAN. 1989



LEGEND

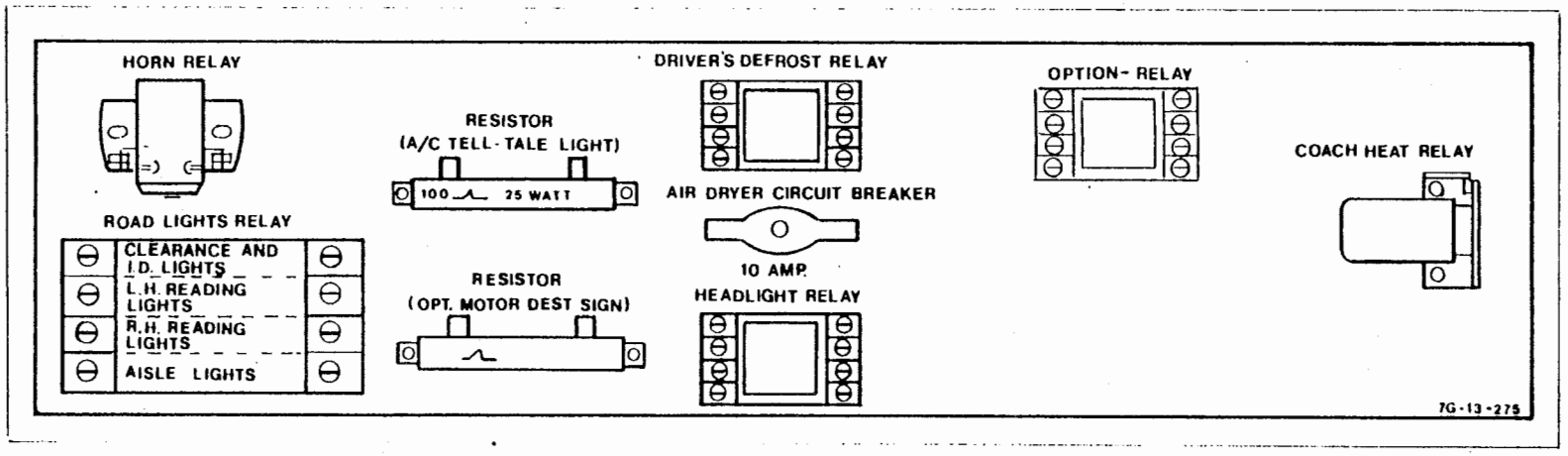
FRONT JUNCTION BOX STUD	B - BK
REAR JUNCTION BOX STUD	B - BR
AIR CONDITIONING JUNCTION BOX STUD	R - RD
SENSING ELEMENT PLUG	O - OR
REMOTE CONTROL BOX HORIZONTAL BLOCK STUD	Y - YL
REMOTE CONTROL BOX VERTICAL BLOCK STUD	G - GR
② ENGINE TERMINAL BLOCK STUD	B - BLU
Ⓑ ENGINE CRADLE HARNESS PLUG	V - VO
⊗ ROOF HARNESS BLOCK STUD	G - GR
----- OPTION	W - WH

WIRING DIAGRAM
PRESSURIZED ETHER START SYSTEM
MODEL: MC-9
DATE: JANUARY 1989

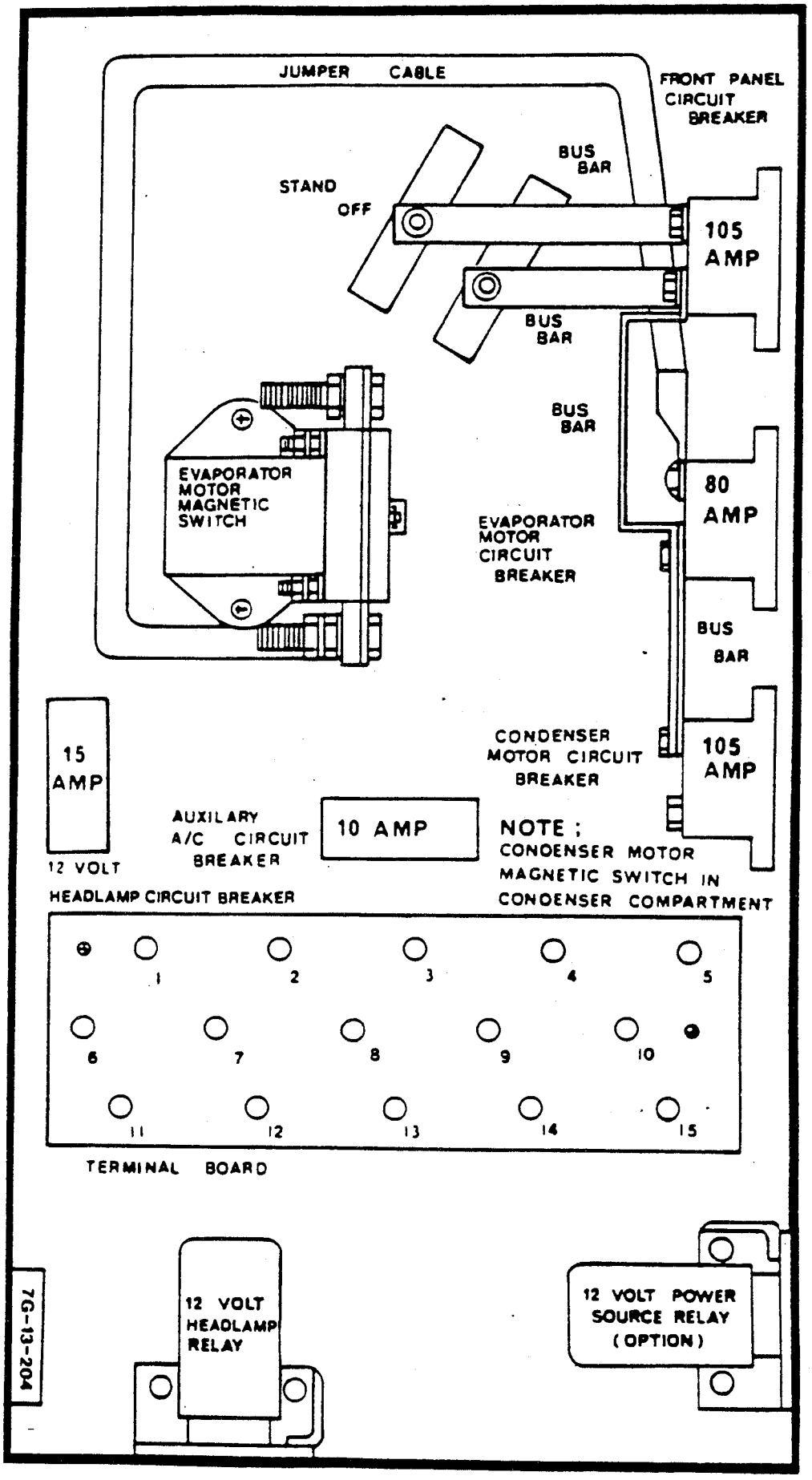


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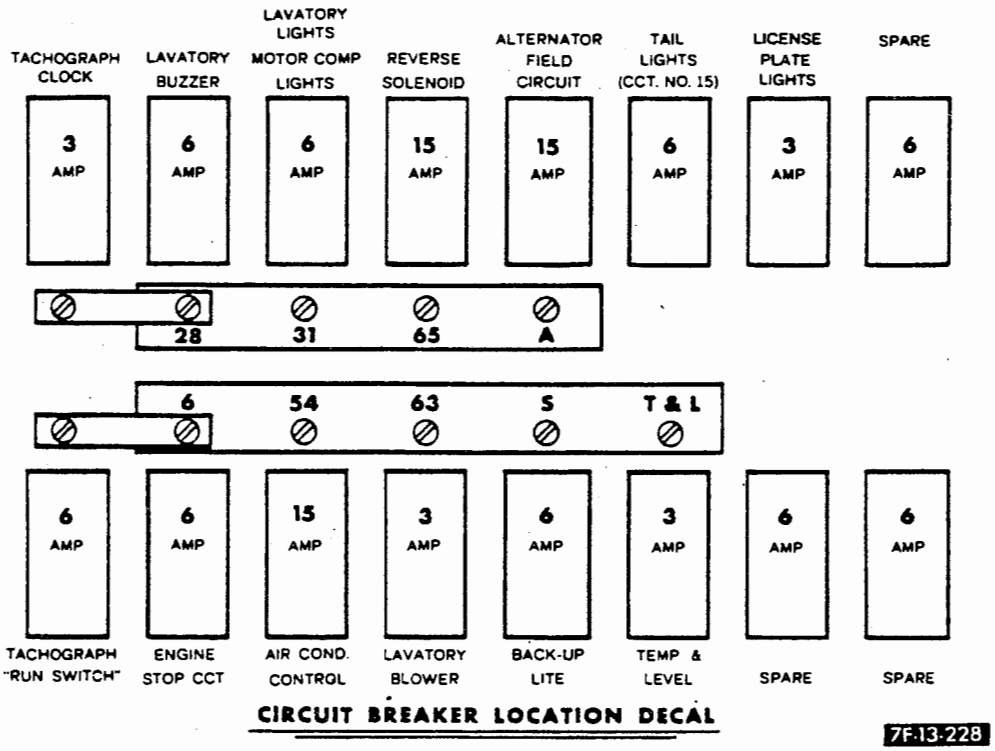
FRONT JUNCTION BOX DECAL
MODEL: MC-9
DATE: JAN. 1989



FRONT JUNTION BOX RELAY LOCATION DECAL
MODEL: MC-9
DATE: JANUARY 1989



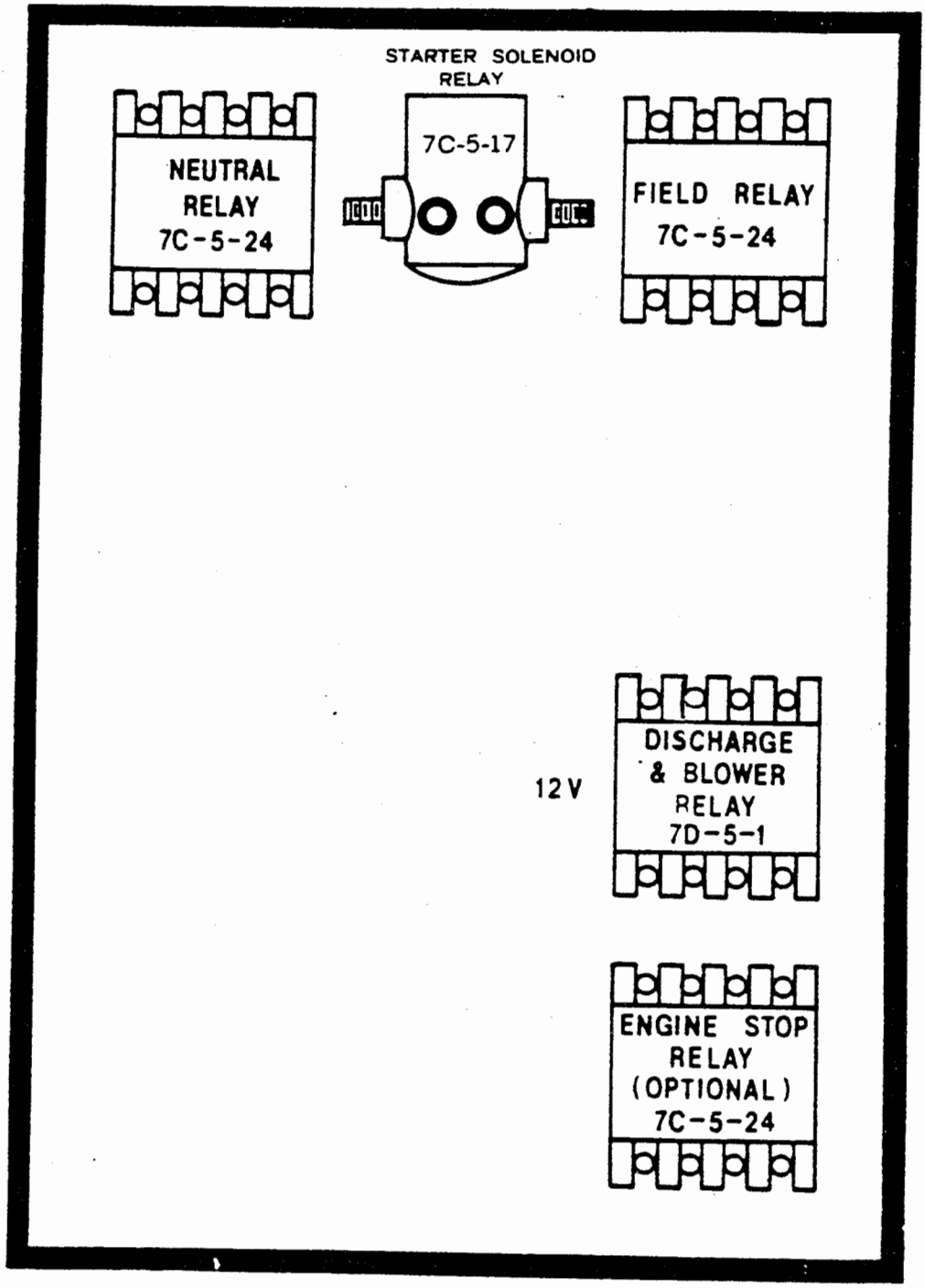
A/C JUNCTION BOX DECAL
MODEL: MC-9
DATE: JAN. 1989



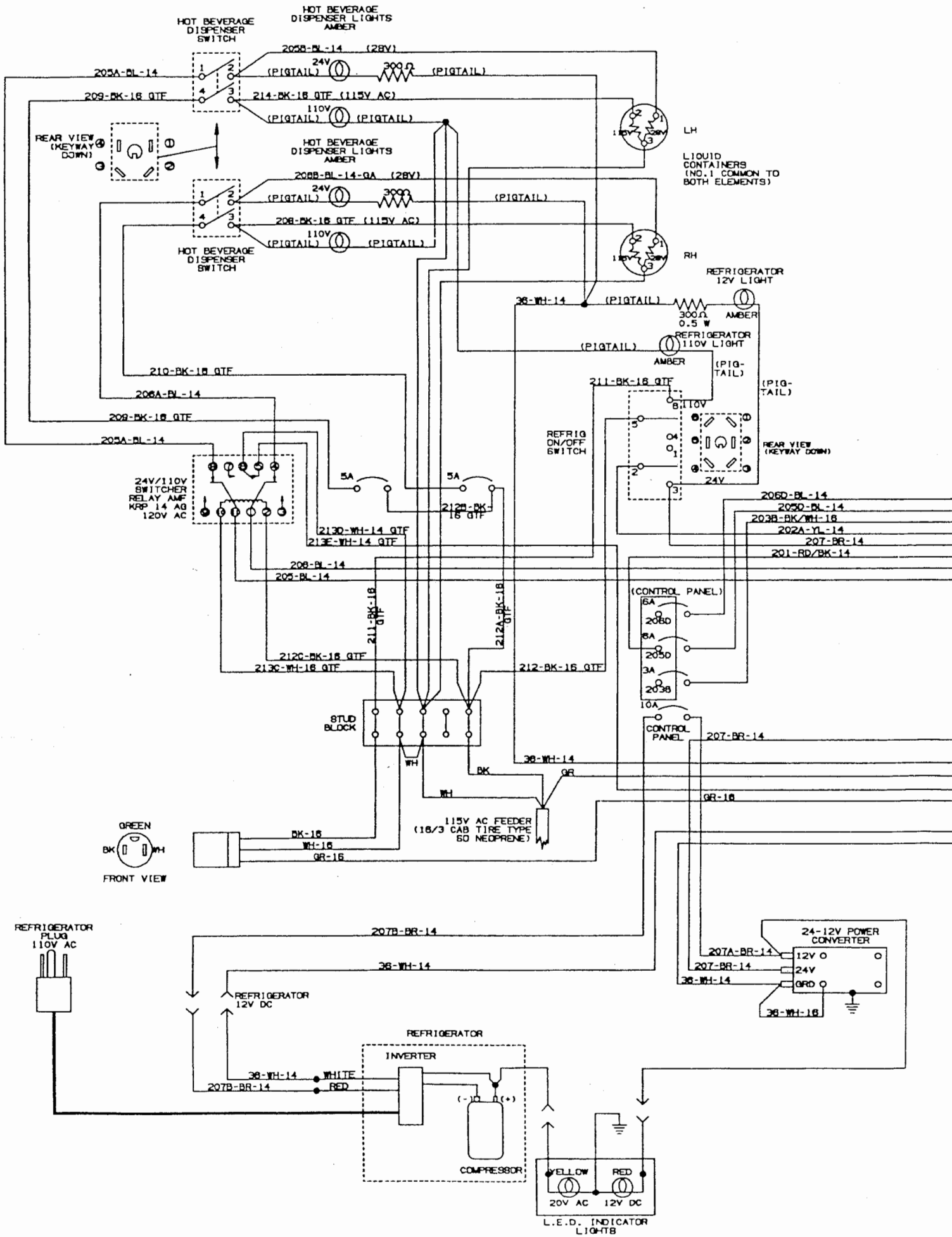
CIRCUIT BREAKER LOCATION DECAL

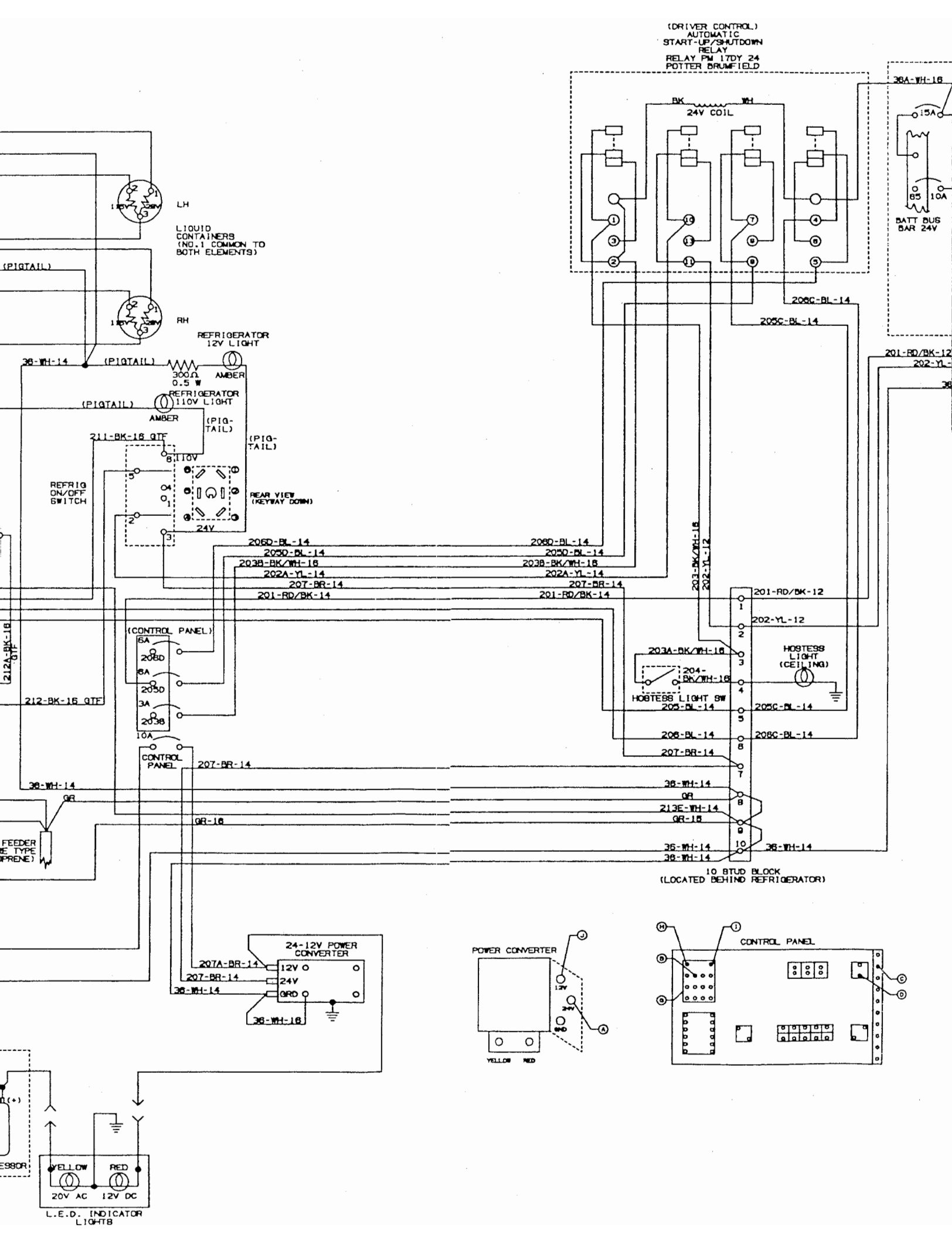
7F-13-228

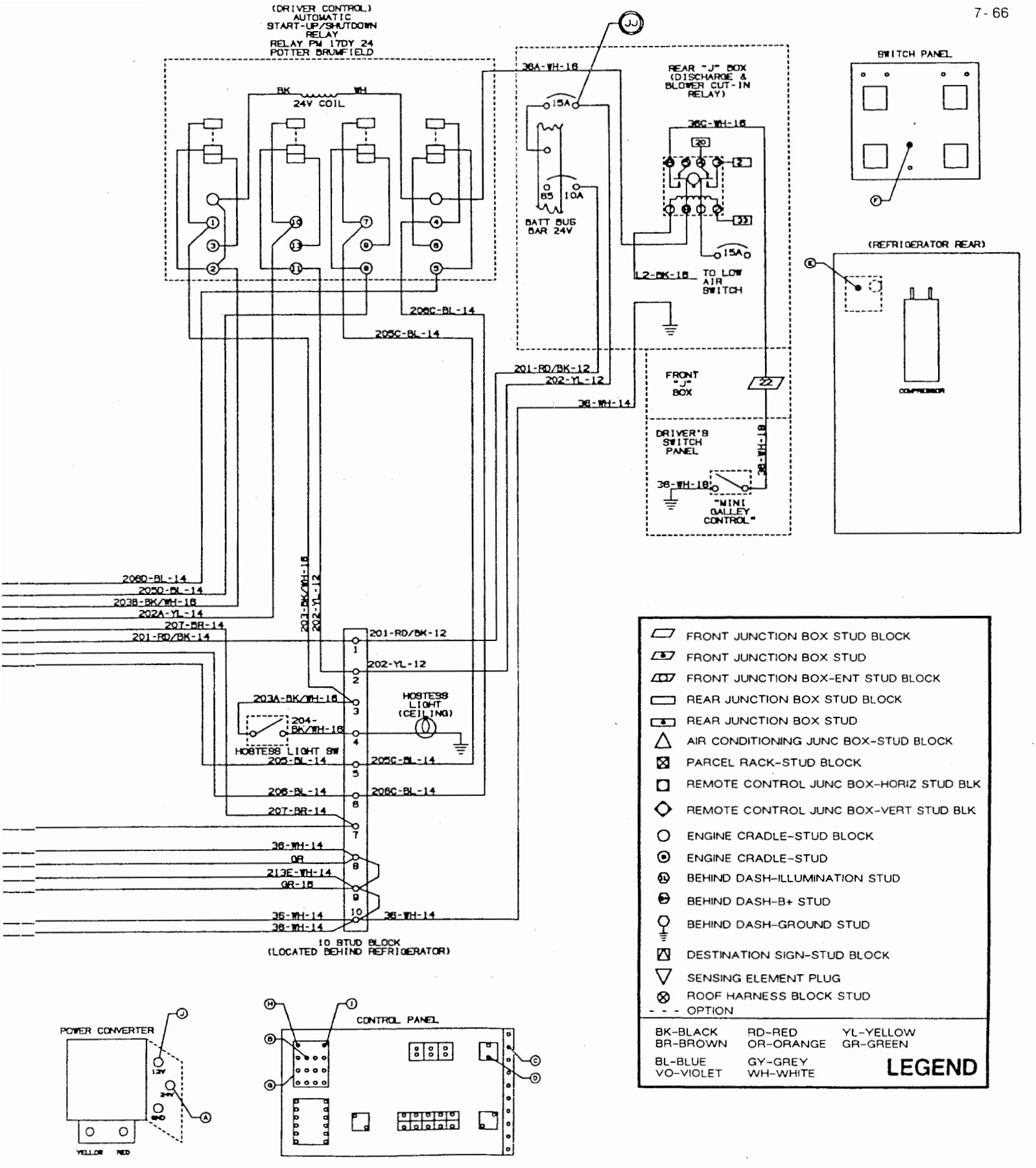
CIRCUIT BREAKER LOCATION DECAL - REAR "J" BOX
MODEL: MC-9
DATE: JAN. 1989



REAR JUNCTION BOX RELAY LOCATION
MODEL: MC-9
DATE: JAN. 1989


HOT BEVERAGE DISPENSER SWITCH
HOT BEVERAGE DISPENSER LIGHTS AMBER
205B-BL-14 (28V)
24V
300Ω
(PIGTAIL)
205A-BL-14
209-BK-16 GTF
214-BK-16 GTF (115V AC)
110V
(PIGTAIL)
REAR VIEW (KEYWAY DOWN)
HOT BEVERAGE DISPENSER LIGHTS AMBER
208B-BL-14-GA (28V)
208-BK-16 GTF (115V AC)
HOT BEVERAGE DISPENSER SWITCH
LH
LIQUID CONTAINERS (NO.1 COMMON TO BOTH ELEMENTS)
RH
REFRIGERATOR 12V LIGHT
36-WH-14
300Ω 0.5 W
AMBER
REFRIGERATOR 110V LIGHT
(PIG-TAIL)
210-BK-16 GTF
206A-BL-14
209-BK-16 GTF
205A-BL-14
211-BK-16 GTF
8.110V
REFRIG ON/OFF SWITCH
24V
REAR VIEW (KEYWAY DOWN)
24V/110V SWITCHER RELAY AMF KRP 14 AG 120V AC
5A
212B-BK-16 GTF
206D-BL-14
205D-BL-14
203B-BK/WH-16
202A-YL-14
207-BR-14
201-RD/BK-14
213D-WH-14 GTF
213E-WH-14 GTF
208-BL-14
205-BL-14
211-BK-16 GTF
212A-BK-16 GTF
(CONTROL PANEL)
6A
208D
8A
205D
3A
203B
10A
212C-BK-16 GTF
213C-WH-16 GTF
212-BK-16 GTF
STUD BLOCK
CONTROL PANEL
207-BR-14
WH
BK
GR
36-WH-14
GR-16
115V AC FEEDER (16/3 CAB TIRE TYPE SO NEOPRENE)
GREEN
BK
WH
FRONT VIEW
BK-16
WH-16
GR-16
REFRIGERATOR PLUG 110V AC
207B-BR-14
24-12V POWER CONVERTER
207A-BR-14
12V
24V
GRD
36-WH-16
REFRIGERATOR 12V DC
REFRIGERATOR
INVERTER
36-WH-14
WHITE
207B-BR-14
RED
(-)
(+)
COMPRESSOR
YELLOW
RED
20V AC
12V DC
L.E.D. INDICATOR LIGHTS


(DRIVER CONTROL)
AUTOMATIC
START-UP/SHUTDOWN
RELAY
RELAY PM 17DY 24
POTTER BRUMFIELD
BK
WH
24V COIL
38A-WH-16
15A
85
10A
BATT BUS
BAR 24V
LH
LIQUID
CONTAINERS
(NO.1 COMMON TO
BOTH ELEMENTS)
(PIGTAIL)
RH
REFRIGERATOR
12V LIGHT
38-WH-14
(PIGTAIL)
300Ω
0.5 W
AMBER
REFRIGERATOR
110V LIGHT
(PIGTAIL)
AMBER
(PIG-
TAIL)
211-BK-16 GTF
(PIG-
TAIL)
8
110V
REFRIG
ON/OFF
SWITCH
REAR VIEW
(KEYWAY DOWN)
24V
206C-BL-14
205C-BL-14
201-RD/BK-12
202-YL-
206D-BL-14
205D-BL-14
203B-BK/WH-16
202A-YL-14
207-BR-14
201-RD/BK-14
203-BK/WH-16
202-YL-12
(CONTROL PANEL)
6A
206D
6A
205D
3A
203B
10A
CONTROL
PANEL
212-BK-16 GTF
212A-BK-16
GTF
207-BR-14
38-WH-14
GR
GR-16
203A-BK/WH-16
204-
BK/WH-16
HOSTESS LIGHT SW
HOSTESS
LIGHT
(CEILING)
205-BL-14
205C-BL-14
206-BL-14
206C-BL-14
207-BR-14
38-WH-14
GR
213E-WH-14
GR-16
36-WH-14
38-WH-14
38-WH-14
10 STUD BLOCK
(LOCATED BEHIND REFRIGERATOR)
FEEDER
E TYPE
PRENE)
24-12V POWER
CONVERTER
207A-BR-14
207-BR-14
38-WH-14
12V
24V
GRD
38-WH-16
POWER CONVERTER
12V
24V
GND
YELLOW
RED
CONTROL PANEL
E980R
YELLOW
RED
20V AC
12V DC
L.E.D. INDICATOR
LIGHTS



WIRING DIAGRAM
MINI-GALLEY
JAN 1989
7G-13-231

Date 1-1-89

MC-9 MAINTENANCE MANUAL

SECTION 8

ENGINE

SUBJECT	PAGE
Diesel Engine Lubricating Oil	8-2
Diesel Lubricating Oil Specifications	8-3
Engine	8-1
Engine Mounts	8-3
Ether Start System	8-7
Fast Idle Overrule and Engine Shutdown	8-7
2-Speed Governor Adjustment	8-4
2-Speed Governor High Speed Spring Adjustment	8-6
Removal and Replacement	8-1
Sending Unit Manifold	8-7
Specifications	8-8
Service Bulletin Page	

:onnect height control valve links and pull down to vent air from rear suspension bellows.

2. Drain the engine cooling system as directed in Section 6 of this manual, remove the cooling blower drive belt.

3. Open drain cock and vent air from the brake system. Disconnect the propeller shaft as outlined in Section 14 of this manual. Disconnect transmission and clutch operating linkage. Disconnect clutch cable. Disconnect throttle linkage.

4. Disconnect exhaust muffler slip joint. Disconnect air lines to air compressor governor and fast idle air cylinder.

5. Disconnect electrical connection to speedometer unit (if used), starting motor, starting motor solenoid, alternator, engine controls, tachometer (if used), oil pressure and engine temperature sending units. If the engine is an electronically controlled model (DDEC), disconnect the main DDEC harness from the electronic control module which is on top and to the front of the engine.

6. Disconnect and remove cooling system connections to radiators, surge tank and coach heating system. Disconnect fuel supply and return lines. Remove connections between air cleaner and engine air inlet horn.

7. Remove the air conditioning compressor drive belts. Raise the coach approximately 4-6" (101.6-152.4 mm) above the road height.

8. Remove the clamp bolts securing the engine sub-frame to the coach body. Position the dolly under the engine cradle. Lower the coach body only sufficiently to transfer the weight of the engine onto the dolly.

CAUTION: Due to the minimum clearance between the air compressor and the top of the engine compartment, extreme care should be used to lower the coach body only enough to free the engine cradle. Clearance between engine cradle and coach engine mounting rail should be ⅛-¼" (3.1-6.3 mm).

9. Remove engine assembly as a unit, carefully withdrawing it from the rear of the coach. To reinstall, the procedure is the reverse of the above.

10. Refill cooling system. If engine fuel system has been drained, it will aid restarting if fuel filters are filled with fuel oil. Remove vent plugs and pour fuel oil into filter body until filters are full.

11. Start engine and check operation. Check fuel and cooling system connections for leakage. Test operation of engine controls and accessories.

DIESEL ENGINE LUBRICATING OILS

The oil capacity of coaches equipped with a 6V-92 engine is 30 U.S. quarts (28.28 liters). Coaches equipped with an 8V-71 or 8V-92 engine have an oil capacity of 32 U.S. quarts (30.28 liters). Oil is added through the oil fill tube (figure 8-2).

All diesel engines require heavy-duty lubricating oils. Basic requirements of such oils are lubricating quality, high heat resistance and control of contaminants.

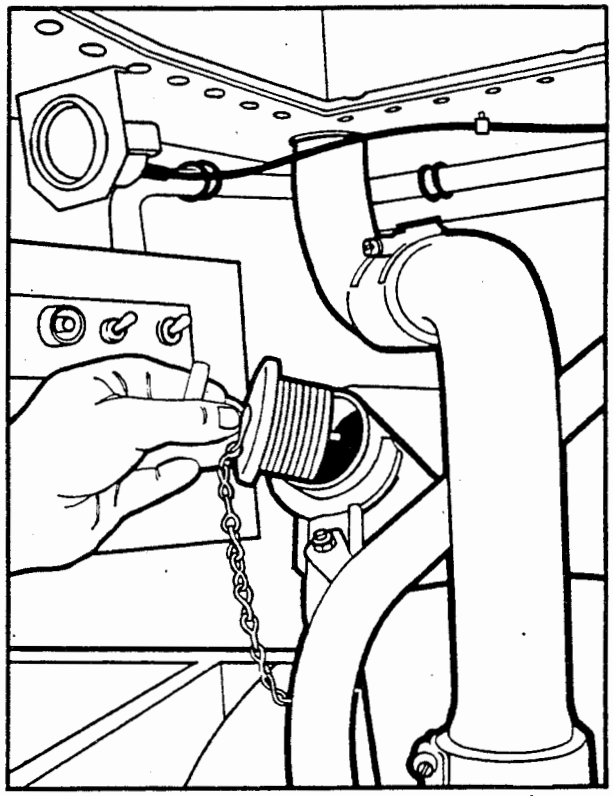


Figure 8-2. Oil Filler Tube.

The reduction of friction and wear by maintaining an oil film between moving parts is the primary requisite of a lubricant. Film thickness and its ability to prevent metal-to-metal contact of moving parts is related to oil viscosity. The optimums for 6V-92, 8V-92 and 8V-71 diesel engines are SAE 40 or 30 weight oil.

Temperature is the most important factor in determining the rate at which deterioration or oxidation of the lubricating oil will occur. The oil should have adequate thermal stability at elevated temperatures, thereby precluding formation of harmful carbonaceous and/or ash deposits.

The piston and compression rings must ride on a film of oil to minimize wear and prevent ring seizure. At normal rates of consumption, oil reaches a temperature zone at the upper part of the piston where rapid oxidation and carbonization can occur. In addition, as oil circulates through the engine, it is continuously contaminated by soot, acids, and water originating from combustion. Until they are exhausted, detergent and dispersant additives aid in keeping sludge and varnish from depositing on engine parts, but such additives in excessive quantities can result in detrimental ash deposits. If abnormal amounts of insolubles form, particularly on the piston in the compression ring area, early engine failure may result.

Oil that is carried up the cylinder liner wall is normally consumed during engine operation. The oil and additives leave carbonaceous and/or ash deposits when subject to the elevated temperatures of the combustion chamber. The amount of deposits is influenced by the oil composition, additive content, engine temperature and oil consumption rate.

MC-9 MAINTENANCE MANUAL

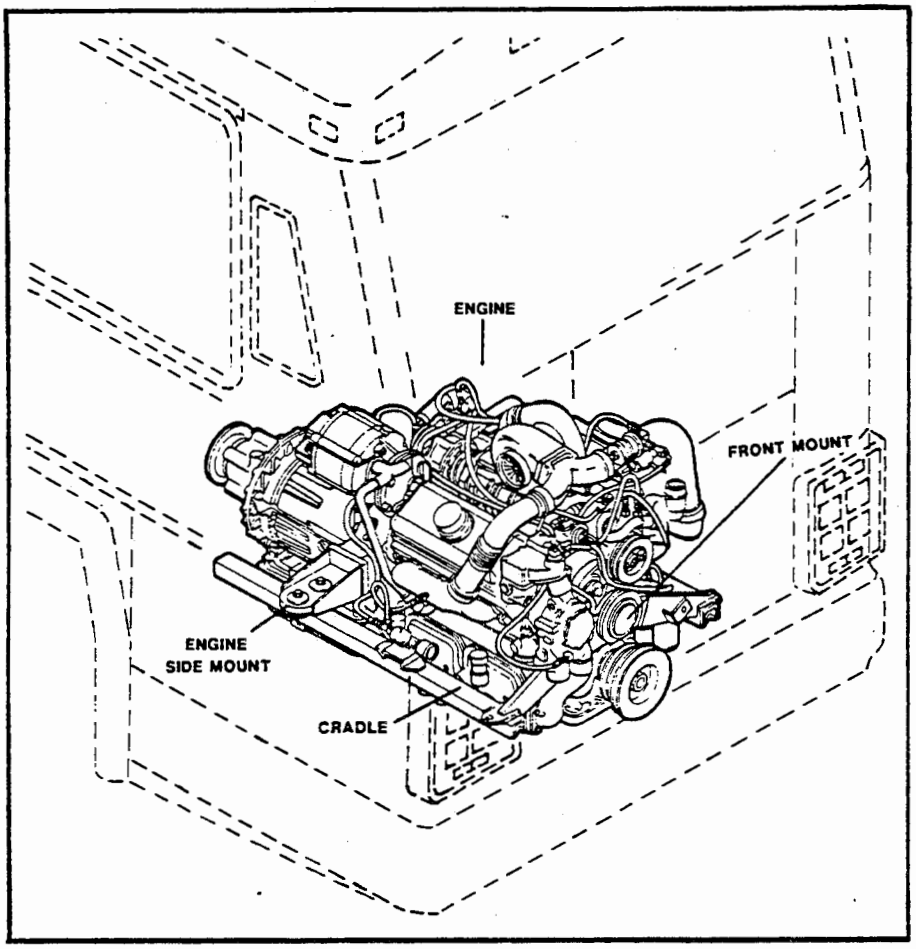


Figure 8-1. Engine Location.

ENGINE

Various Detroit Diesel Engines are used in MC-9 coaches. The 6V-92TA engine is the standard engine; 8V-71 and 8V-92TA engines are optional. Electronically controlled models of the 6V-92TA and the 8V-92TA engines are also used. The general specifications of the engines are shown in the following chart.

Engine Specifications

	6V-92TA	8V-92TA	8V-71
Type	2 Cycle	2 Cycle	2 Cycle
Number of Cylinders	6	8	8
Bore (inches)	4.84	4.84	4.25
Bore (mm)	123	123	108
Stroke (inches)	5	5	5
Stroke (mm)	127	127	127
Comp. Ratio (Nominal) (Turbo. Engines)	17 to 1	17 to 1	—
Comp. Ratio (Nominal) ("N" Engines)	—	—	18.7 to 1
Total Displacement - Cu. In.	552	736	568
Total Displacement - Liters	9.05	12.07	9.32
Number of Main Bearings	4	5	5
Rated Full Load Speed (RPM)	2100	2100	2050

Maintenance and repair information on the engine will be found in the engine manufacturer's service manuals. Engine controls, accessories and related components are covered in the applicable sections of this manual.

Refer to Section 6 (Cooling), 7 (Electrical), 9 (Fuel), and 10 (Lubrication).

To conform with engine manufacturer's practice, TMC/MCI Parts Book, Maintenance Manuals, Service Bulletins and other technical publications identify all engine parts as "L.H.", "R.H.", "Front" or "Rear" when viewing the engine from the flywheel end. This is opposite to the position of these parts with the engine installed in the coach, but the engine manufacturer's designations have been retained to eliminate potential misunderstanding in engine parts identification.

All other parts of the coach are designed "L.H.," "R.H.," "Front" or "Rear" in relation to the normal position of the driver facing forward.

REMOVAL AND REPLACEMENT

The engine unit, including transmission, clutch, air compressor and alternator, may be removed from the coach as a unit for repair to engine or related components. Refer to figure 8-1.

To facilitate removal and replacement of the engine unit and to provide a convenient means of supporting the engine and related components during service work, the use of a dolly is recommended. Such a dolly may be made locally. Refer to tool listings at the end of this section for drawing of dolly.

1. The coach should be driven into a twin-rail hoist and blocks placed between axle bumpers and bumper stops. Dis-

These rubber mounts should be replaced whenever the engine is removed from the coach (e.g. clutch change, etc.).

The following procedure is recommended for replacement of motor mounts:

1. Remove the existing rubber mounts from brackets.

2. Lubricate new rubber mounts with water and place in position between bracket and engine cradle. By use of a small jack under the cradle, the mounts may be installed in engine bracket.

CAUTION: To properly insert the engine mounts, only water should be used as a lubricant. Insertion of the mounts into the socket using glycerine or any other lubricant will result in the tail of the mounts flaring out with the rubber rupturing or a potential rupture after each installation.

3. Install engine mount bolts with new retaining washer but do not tighten until the full weight of engine is bearing on cradle assembly.

Improper installation of the press fit type motor mounts can contribute to excessive engine vibration. When new mounts are installed, mount bolts should be left loose until engine can be run for a short period of time. If engine is accelerated a few times, the rubber mount will find its correct position and then mount bolts can be torqued and cotter keys installed.

4. When reinstalling the engine cradle assembly, the body tie bar should be installed before attempting to tighten cradle U-bolts. the center U-bolts should be tightened first.

If motor-mount studs are being installed in the transmission case, turn the studs in until they "shoulder out." Check to ensure each stud has reached full thread engagement and snug up no more than ¼ turn. Motor-mount bracket and hardware can then be installed. Tighten lock nuts to 170-198 ft. lbs. (231-268 Nm) torque.

TWO SPEED GOVERNOR ADJUSTMENT (Mechanically Controlled Engines)

The service procedure below provides the necessary inspection instructions for obtaining the maximum operating efficiency of the two speed governor (figure 8-5). This procedure should be accomplished every 30 months or every 50,000 miles (80,000 km), as part of regular coach maintenance.

The engine speeds specified in this procedure are recommended as follows: High maximum no-load speed 2250 rpm; low maximum no-load speed 1850 rpm. The 2250 rpm is achieved by a shim pack inside the two speed governor. Adding shims increases the high maximum no-load and taking shims out decreases the speed. The low maximum no-load engine speed is achieved by an adjusting screw (see figure 8-6).

NOTE: The 2250 rpm is required for coaches equipped with the later version automatic transmission (HT-740), unless the transmission shift points have been adjusted downward. The 1850 rpm will give a coach top speed of approximately 67 mph when equipped with a 3.33:1 rear axle.

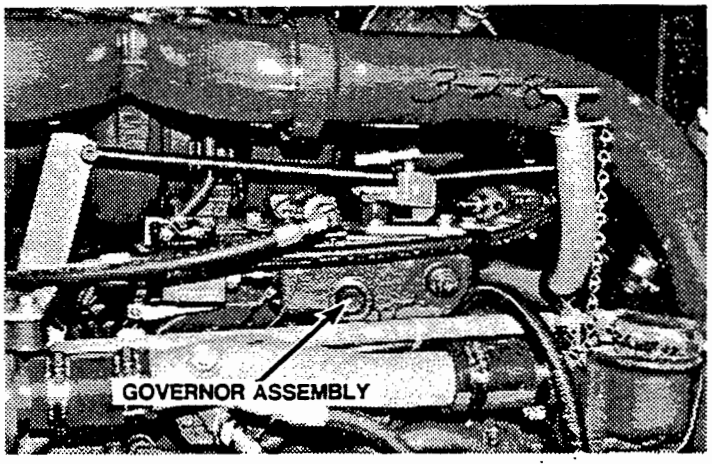


Figure 8-5. Location of Governor.

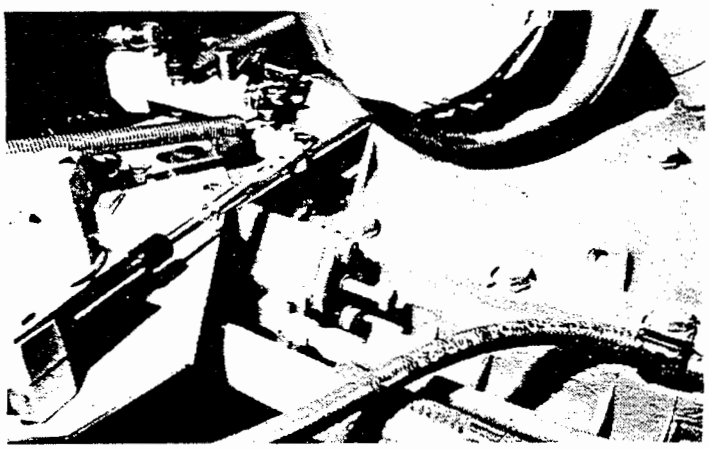


Figure 8-6.

1. The engine injector control levers should be set in accordance with DDA Service Manual 6SE350, Section 14.3. Make sure the fast idle cylinder projects ⅝" (15.88 mm) from the lock nut to prevent interference while adjusting the maximum no-load speeds.

2. Start the engine and allow it to reach normal operating temperature.

3. Refer to figure 8-6. Disconnect the air line to the two speed governor spring housing.

4. Set the speed control lever (figure 8-7) in the maixmum speed position. Using a tachometer, check and record the engine rpm. This is the maximum no-load low engine speed (approximately 1850 rpm) which will be restored at the end of this procedure.

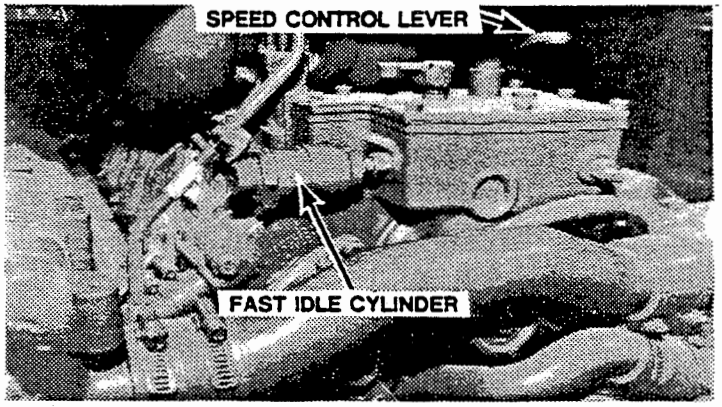


Figure 8-7. Control Lever and Fast Idle Cylinder.

MC-9 MAINTENANCE MANUAL

LUBRICATING OIL SPECIFICATIONS

Oil quality is the responsibility of the oil supplier. (The term "oil supplier" is applicable to the refiners, blenders and rebranders of petroleum products, and does not include distributors of such products.)

There are many brands of commercial crankcase oil marketed today. Obviously, engine manufacturers or users cannot completely evaluate the numerous commercial oils. The selection of a suitable lubricant in consultation with a reliable oil supplier, observance of his oil drain recommendations (based on used oil sample analysis and experience) and proper filter maintenance, will provide the best assurance of satisfactory oil performance.

Lubricating Oil Recommendation.

API Letter Code Service Classification	Military Specification	SAE Grade
CB	MIL-L-2104A (Supplement 1)	40 or 30
CC	MIL-L-2104B	40 or 30
CD/SC	MIL-L-2104C	40 or 30
CD	MIL-L-45199B (Series 3)	40 or 30
CC/SE	MIL-L-46152	40 or 30
Numerous	Universal	40 or 30

SAE 40 grade oil is recommended in 8V-71 and Series 92 diesel engines. The expected ambient temperatures and engine cranking capability must be considered by the owner-operator when selecting the proper grade of oil. Only when the ambient temperatures and engine cranking capabilities result in difficult starting should SAE 30 grade oil be used.

The 8V-71 and Series 92 engines have given optimum performance and experienced the longest service life with the following oil performance levels having the following ash and zinc limits: The sulfated ash limited (ASTMD-874) shall not exceed 1.000% by weight, except lubricants that contain only barium detergent-dispersant salts where 1.500% by weight is allowed. The zinc content, as zinc diorganodithiophosphate, shall be a minimum of 0.07% by weight.

Lubricants meeting specification MIL-L-46167 are used in Alaska and other extreme sub-zero locations. Generally they may be described as 5W-20 multigrade lubricants made up of synthetic base stock and having low volatility characteristics. Although they have been used successfully in some severe cold regions, they are not considered as desirable as SAE 40, or SAE 30 oils with auxiliary heating aids. For this reason, they should be considered only where engine cranking is a severe problem and auxiliary heating aids are not available on the engine.

POLICY ON LUBRICANT ADDITIVES

TMC/MCI does not recommend or support the use of any supplementary lubricant additives. These include all products marketed as top oils, break-in oils, graphitizers and friction-reducing compounds.

NOTE: TMC/MCI warranty applicable to 8V-71 and Series 92 diesel engines provides in part that the provisions of such warranty shall not apply to any engine unit which has been subject to misuse, negligence or accident. Accordingly, malfunctions attributable to neglect or failure to follow the manufacturer's fuel or lubricating recommendations may not be within the coverage of the warranty.

SERVICE AND INSPECTION INTERVALS

Generally, operating conditions will vary for each engine application, even with comparable mileage or hours and, therefore, maintenance schedules can vary. A good rule of thumb for piston, ring and liner inspection, however, would be at 45,000 miles (54,000 km) or 1,500 hours for the first such inspection and at 30,000 miles (45,000 km) or 1,000 hour intervals thereafter.

A suggested preventive maintenance practice is a regularly scheduled testing of fuel and lubricating oils by either the oil supplier or an independent testing laboratory. Since the oil supplier knows the physical properties of his products and maintains laboratories to determine practical oil drain intervals, take advantage of this service and request him to check drained oil samples frequently and report the results to you.

ENGINE MOUNTS

The engine is mounted to the engine cradle by means of six rubber mounts, two on each side of the flywheel housing and two at the front of the engine (rear of the coach). See figures 8-3 and 8-4.

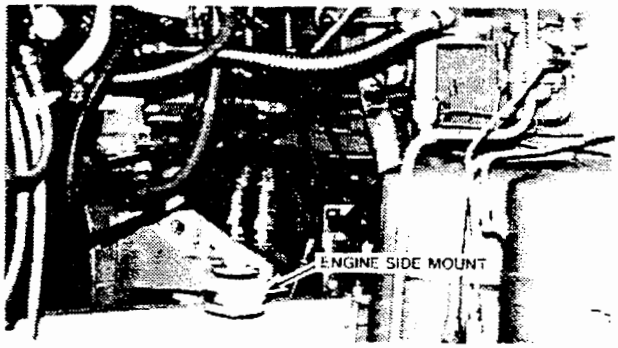


Figure 8-3. Engine Mount.

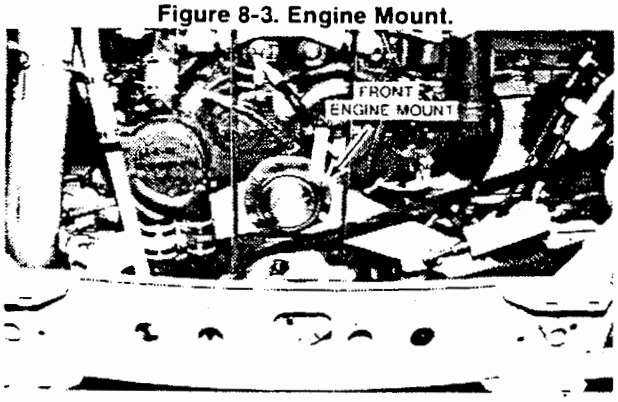


Figure 8-4. Front Engine Mount.

MC-9 MAINTENANCE MANUAL

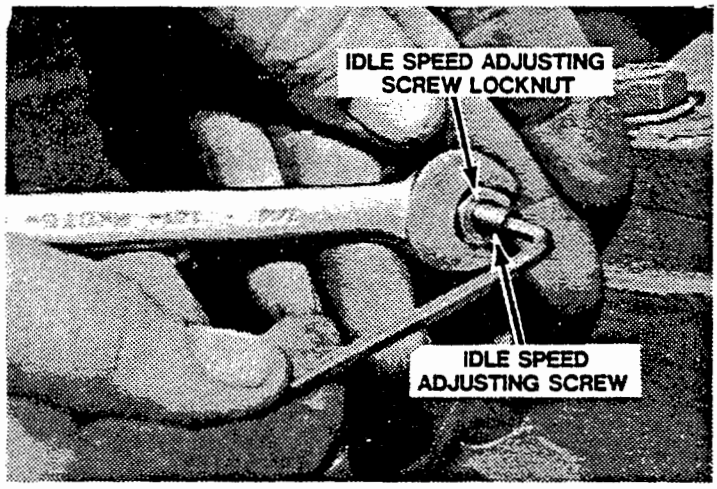


Figure 8-9. Idle Speed Adjustment.

25. Recheck the maximum no-load speeds. If increased more than 25 rpm, back off the fast idle cylinder until the increase is less than 25 rpm.

TWO SPEED GOVERNOR HIGH SPEED SPRING REPLACEMENT

HT-740 automatic transmissions may not shift from third to fourth gear under full throttle if the high speed spring in the two speed governor has "taken a set." When this occurs, the engine maximum no-load speed may be reduced to affect the full-throttle upshift from third to fourth.

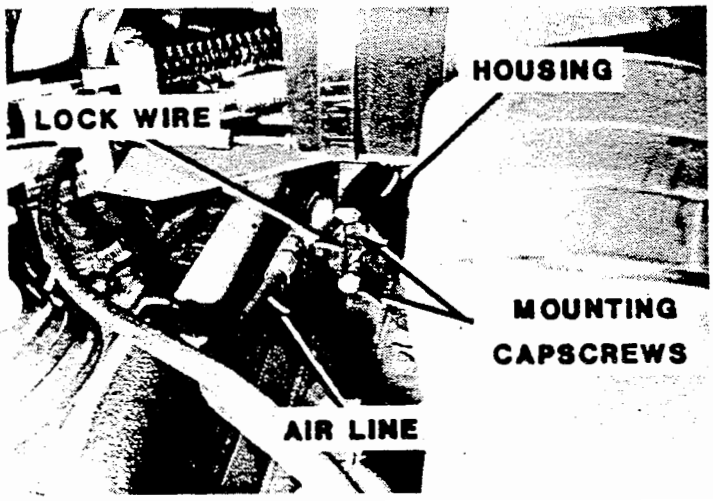
No transmission problems are associated with this condition. If engine maximum no-load speed is less than the recommended 2250 RPM, the new high speed spring will increase the speed.

New springs can be ordered from Detroit Diesel Allison, part number 23501874. The replacement springs are color coded with red and brown paint on one side of the spring.

Read the entire procedure before starting.

1. Refer to figure 8-10. Disconnect the air line to the two-speed governor housing.

2. Cut and remove the lock wire that is routed through the mounting capscrews and low maximum no-load adjusting screw.



CAUTION: Exercise care in removing the spring housing so that the mounting gaskets are not damaged.

3. Remove the two capscrews mounting the housing to governor and remove the housing. Keep the internal parts within the housing when removing the housing from the governor.

4. Remove any cylinders and/or auxiliary devices mounted on the governor cover.

5. Remove the eight cover screws and lift the governor cover, with the stop lever and cover gaskets, from the governor.

CAUTION: The retainer to be removed in Step 6 is under spring tension from inside the governor. Use adequate counter-force when removing it to prevent the expulsion of parts due to internal spring pressure.

6. Refer to figure 8-8. Remove the spring retainer from the governor governor by rotating it counterclockwise. Use DDA special tool J-1652-01.

7. Refer to figure 8-8. Remove the two-speed governor spring assembly from inside the governor. Keep the parts intact as you guide them through the hole in the governor wall.

8. Disassemble the parts necessary to isolate and remove the high-speed spring. Do not change the location of the lock nut on the set screw.

9. Replace the old spring. Check that the color code on the new spring is red and brown.

10. Reassemble the parts. Make sure the adjusting pin seats properly in the plunger (figure 8-8). Insert the assembly through the hole and into position inside the governor.

11. Place the retainer over the spring and compress it to start the threads into the hole of the governor. Tighten the retainer securely.

12. Install a new gasket P/N 8924869 and reinstall the governor cover with the eight bolts.

13. Install the spring housing with the gaskets on the governor. Connect the air line.

NOTE: Replacing the high speed spring may change the settings of the Governor Gap, Injector Rack Control Levers, Maximum No-Load Engine Speed, Idle Speed and Buffer Screw. Refer to section 14 of the applicable DDA engine maintenance manual to adjust the above items.

MC-9 MAINTENANCE MANUAL

5. Return the speed control lever to the low speed setting and turn the engine off.

6. Connect the air line previously removed from the governor spring housing.

7. Start the engine and place the speed control lever in the maximum position. Check and record the engine rpm (maximum no-load high engine speed — recommended to be 2250 rpm). Turn the engine off.

8. Determine the shims required for the 2250 high maximum no-load engine speed. Each 0.010-inch shim added to or taken from the shim pack will respectively increase or decrease engine rpm 10 rpm. Shims 0.100-inch thick change engine speed approximately 100 rpm.

NOTE: The shim pack is inside the two speed governor. DDA part number of the 0.010-inch shim is 5123922. The 0.100-inch shim's part number is 5123923.

9. Disconnect the air line to the governor spring housing. Cut and remove the lock wire that is routed through the mounting capscrews an the low maximum no-load adjusting screw.

CAUTION: When removing the two speed governor, use care not to damage the governor mounting gaskets. Also, keep the internal parts within the housing during removal.

10. Remove the two capscrews mounting the housing to the governor and remove the housing. Refer to figure 8-8.

11. Place the housing on a clean work surface and separate the retainer and sleeve from the piston. The shim pack is located inside the piston, between the piston and the sleeve.

12. Add to the shim pack (or take from it) the number of shims necessary for a high maximum no-load speed of 2250 rpm. Reassemble the shims, sleeve, retainer and piston in the housing.

13. Install the housing with the gaskets on the governor and connect the air line.

14. Place the main battery switch in the ON position.

15. Start the engine and allow it to reach normal operating temperature.

16. Place the speed control lever in the high speed position and check for the recommended high maximum no-load speed (2250 rpm) with the tachometeer. If the speed is too high or too low, repeat steps 7 thru 16 to add or take out shims..

17. Place the speed control lever in the low position and turn off the engine.

18. Disconnect the air line to the governor spring housing and start the engine.

19. Place the speed control lever in the high speed position and check the low maximum no-load speed with the tachometer. Adjust the low maximum no-load speed adjusting screw (on the governor spring housing) for 1850 rpm or the engine speed that was recorded in step 4.

20. Reconnect the air line to the housing and install the locking wire.

NOTE: Major changes in the shim pack thickness may change the settings of the governor gap, injector rack control levers, idle speed and buffer screw. Refer to section 14 of the applicable DDA engine manual to adjust the above items.

21. Adjust idle speed screw (figure 8-9) until the engine rpm is approximately 15 rpm below recommended idle speed (650 rpm with automatic transmission; 500 rpm with manual transmission).

NOTE: Use of the fast idle cylinder may be required to eliminate engine roll. After idle speed is established, back out the cylinder to the previous setting of 5/8" (15.88 mm).

22. Hold the idle screw and tighten the lock nut (figure 8-9).

23. Install the high speed spring retainer and tighten to two bolts (figure 8-8).

24. Turn the fast idle cylinder inward so it contacts the differential lever as lightly as possible while still eliminating engine roll.

NOTE: Do not increase engine idle speed more than 15 rpm with fast idle cylinder.

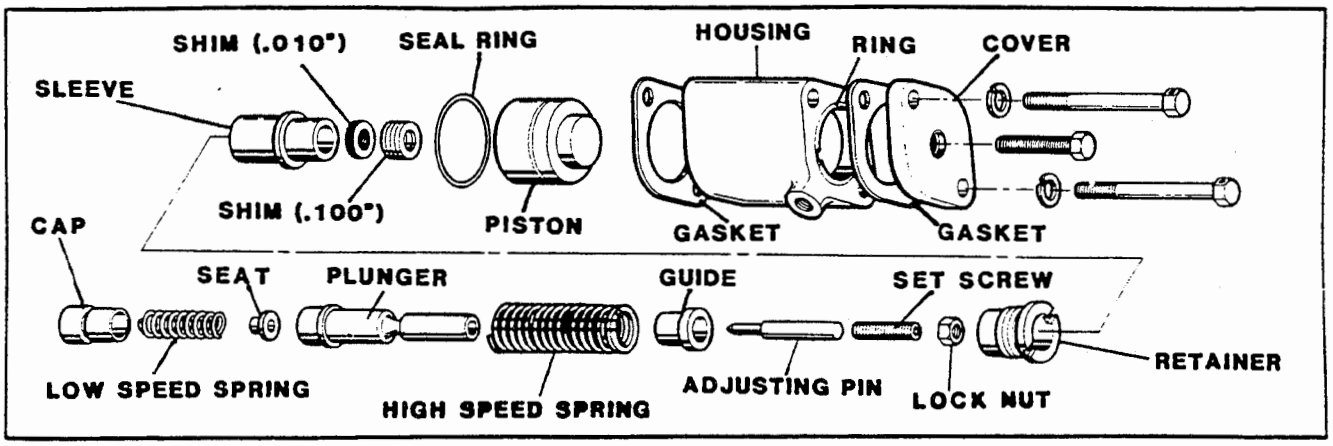


Figure 8-8. Governor Parts Breakdown.

MC-9 MAINTENANCE MANUAL

MISCELLANEOUS ENGINE TORQUE VALUES

(For complete engine specifications refer to the appropriate Detroit Diesel Engine Service Manual.)

Crankshaft Pulley Bolt	300 lb-ft (407 Nm)
Crankshaft Pulley to Hub Bolts	35 lb-ft (47 Nm)
Front Motor Mount Bolts (8V-92) (Rear of Coach)	180 lb-ft (244 Nm)
Rear Motor Mount Bolts (8V-92)	225 lb-ft (305 Nm)
Front Motor Mount Bolts (6V-92 & 8V-71) (Rear of Coach)	30 lb-ft (41 Nm)
Rear Motor Mount Bolts (6V-92 & 8V-71)	225 lb-ft (305 Nm)

FAST IDLE SOLENOID AND CYLINDER SPECIFICATIONS

Solenoid	
Manufacturer	Skinner
Model	V5C45380
Voltage	24
Air Cylinder	
Manufacturer	Schrader
Model	3351-A

14. Start the engine and check for normal operation.
15. Stop the engine and install a new locking wire. This completes the procedure.

FAST IDLE OVERRULE AND ENGINE SHUT-DOWN VALVES AND CYLINDERS

REMOVAL AND DISASSEMBLY

CAUTION: When removing air lines, loosen connections slowly to vent air pressure.

1. Disconnect air pressure lines from valves and cylinders.
2. Remove quick-disconnect plug from valves.
3. Remove stud nuts retaining valves to mounting bracket
4. Remove screws retaining cylinder to governor cover.
5. Remove cap from piston rod.
6. Pull piston and rod assembly out of cylinder.
7. Reverse for assembly.

INSTALLATION

1. Mount valves and air cylinders as shown in figure 8-12.
2. Install bell cranks and adjust to have 1/32" (.79 mm) clearance with piston extended.
3. Install air supply lines, quick disconnect plugs, ground terminals and clip to left-hand cylinder head.

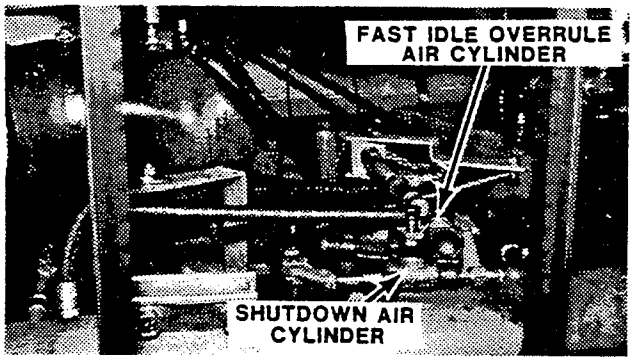


Figure 8-12. Engine Control System.

SENDING UNIT MANIFOLD

The sending unit manifold is mounted in the engine compartment upper frame to provide additional protection to sending units.

Figure 8-13 shows the manifold with the 3 lb. oil tell-tale sending unit, oil pressure gauge sending unit and the manual oil pressure gauge.



Figure 8-13. Sending Unit Manifold.

COLD WEATHER ETHER START SYSTEM

DESCRIPTION

Cold weather starting is facilitated by the injection of ether into the engine. Ether travels through a line from the ether solenoid valve to an atomizer which is installed in the engine blower housing. A replaceable ether bottle is connected to the solenoid valve.

OPERATION

The coach must be in the start mode (main switch "ON") and the ether switch at the driver's instrument panel must be depressed before the ether injection process will occur. The ether start switch is wired to the starting circuit and becomes inoperative after the engine is running and fuel pressure reaches 9 p.s.i., preventing ether injection during normal engine operation. Additionally, the ether system thermostat, which is surface mounted at the water pump housing, must be sensing a temperature of 60° +6°F before the solenoid valve will open and allow ether to flow to the engine. Refer to the wiring diagram for the ether start system in Section 7 of this manual.

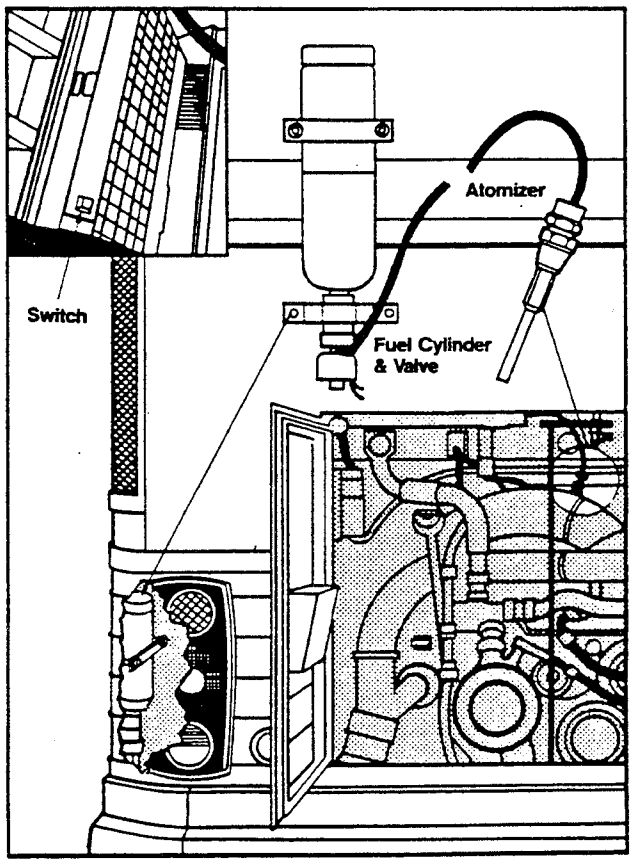
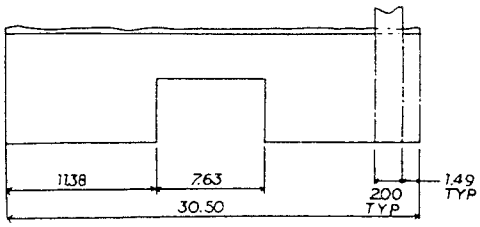
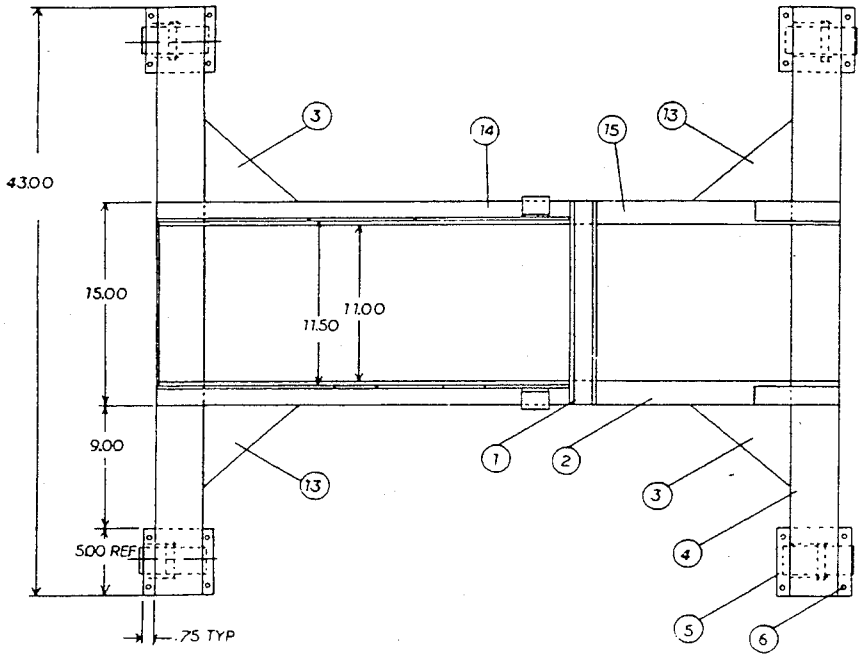
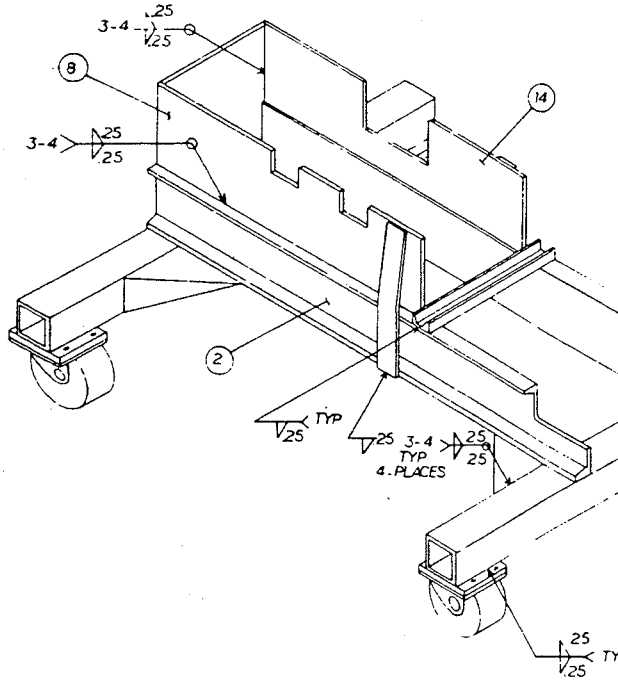
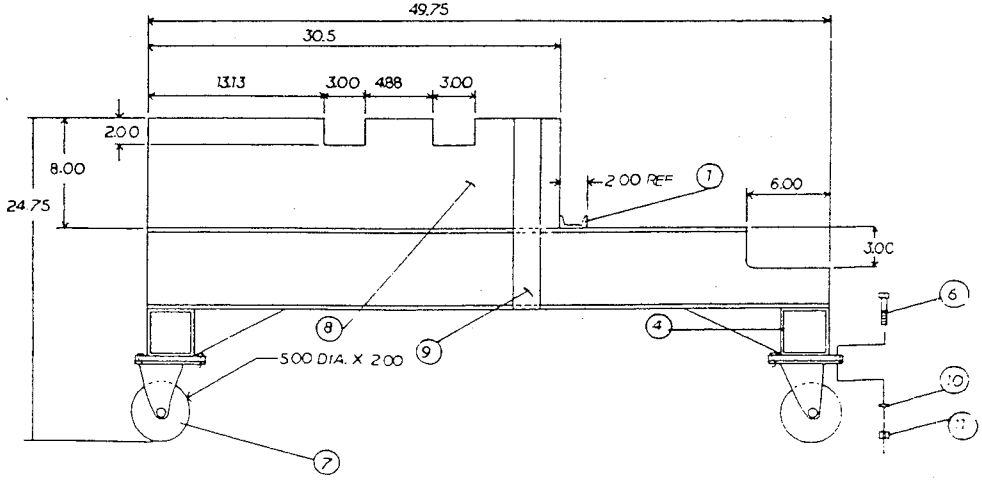


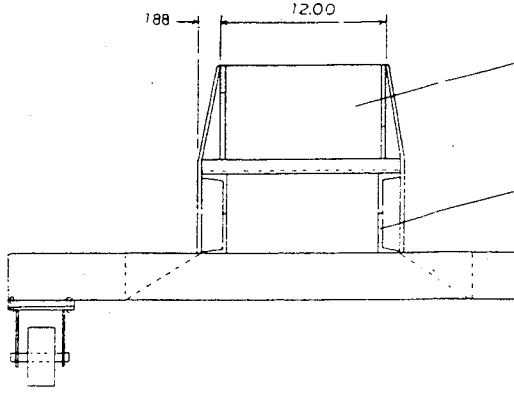
Figure 8-14. Pressurized Ether Starting System.





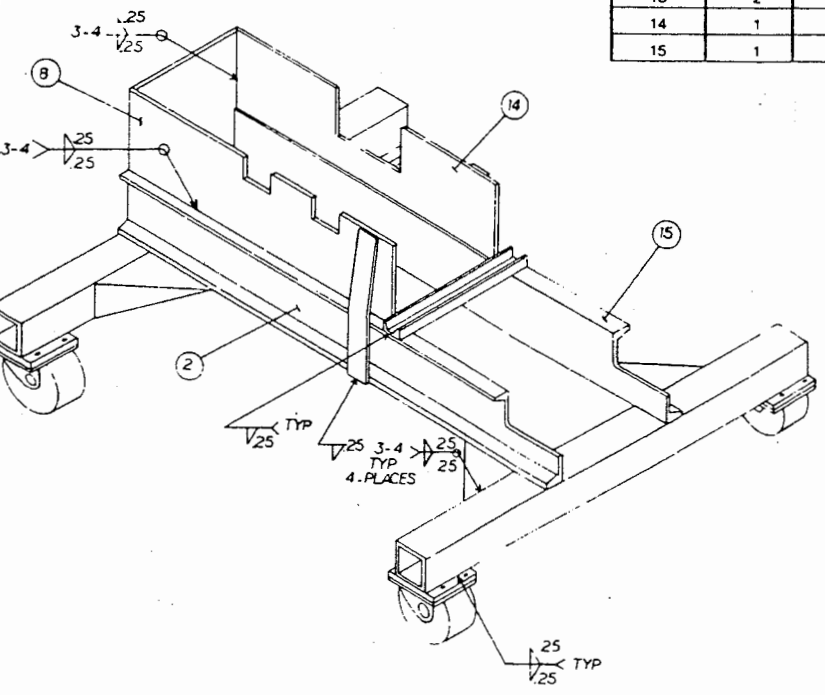


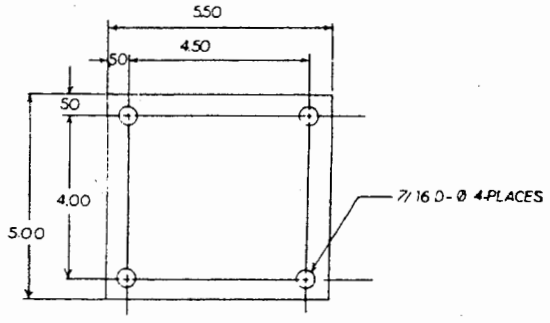




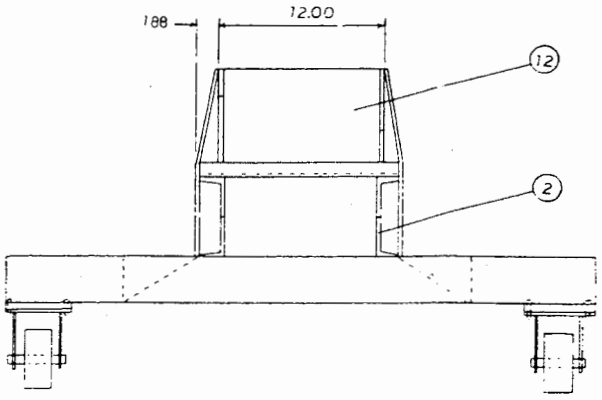
20-1 Engine Dolly

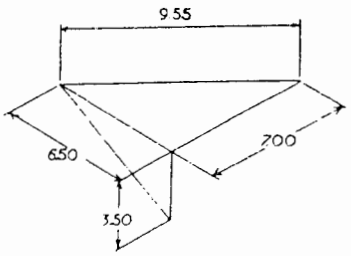
ITEM	QUAN.	DESCRIPTION	MATERIAL
		ENGINE DOLLY	
1	1	U-CHANNEL	1x2x3/16x15
2	1	U-CHANNEL	2x6x3/16x49.75
3	2	PLATE-GUSSETS	1/4x6.5x10.50
4	2	TUBING SQUARE	1/4 WALL 4.0 SQx43
5	4	PLATE-CASTERS	1/4x5x5.5
6	16	BOLTS	3/8 DIAx1.25 GRADE 5
7	4	CASTERS: PHENOLIC SWIVEL	5.00 DIA 5ES87
8	1	PLATE--SIDE	1/4x8.00x31.00
9	2	BAR STOCK	1/2x2/14
10	16	FLATWASHER	3/8 WASHER
11	16	NUT	3/8 NUT
12	1	PLATE-END	1/4x12.00x15.00
13	2	PLATE-GUSSETS	1/4x6.5x10.50
14	1	PLATE-SIDE	.25x8.00x31.00
15	1	U-CHANNEL	2.00x6.00x.19x49.75





DETAIL ITEM # 5
SCALE 1-2





DETAIL ITEM # 3
SCALE 1-4
ITEM#13 OPPOSITE
FORMED 30° WITH .25
SCALE 1-4

Date 1-1-89

MC-9 MAINTENANCE MANUAL

SECTION 9

FUEL SYSTEM

SUBJECT	PAGE
Accelerator and Brake Pedal Travel	9-5
Air Cleaner (Oil Type)	9-6
Air Cleaner (Dry Type)	9-7
Alcohol, Gasohol and Gasoline in Diesel Fuel	9-3
Cruise Control	9-9
Cruise Control Preventive Maintenance	9-12
Diesel Fuel	9-1
Fuel Strainer and Filter	9-5
Fuel System Priming	9-4
Fuel Tank Removal	9-4
Service Tools	9-21
Specifications	9-21
System Road Test	9-14
Transmission Modulator Valve	9-5
Troubleshooting Cruise Control	9-14
Service Bulletin Page	

MC-9 MAINTENANCE MANUAL

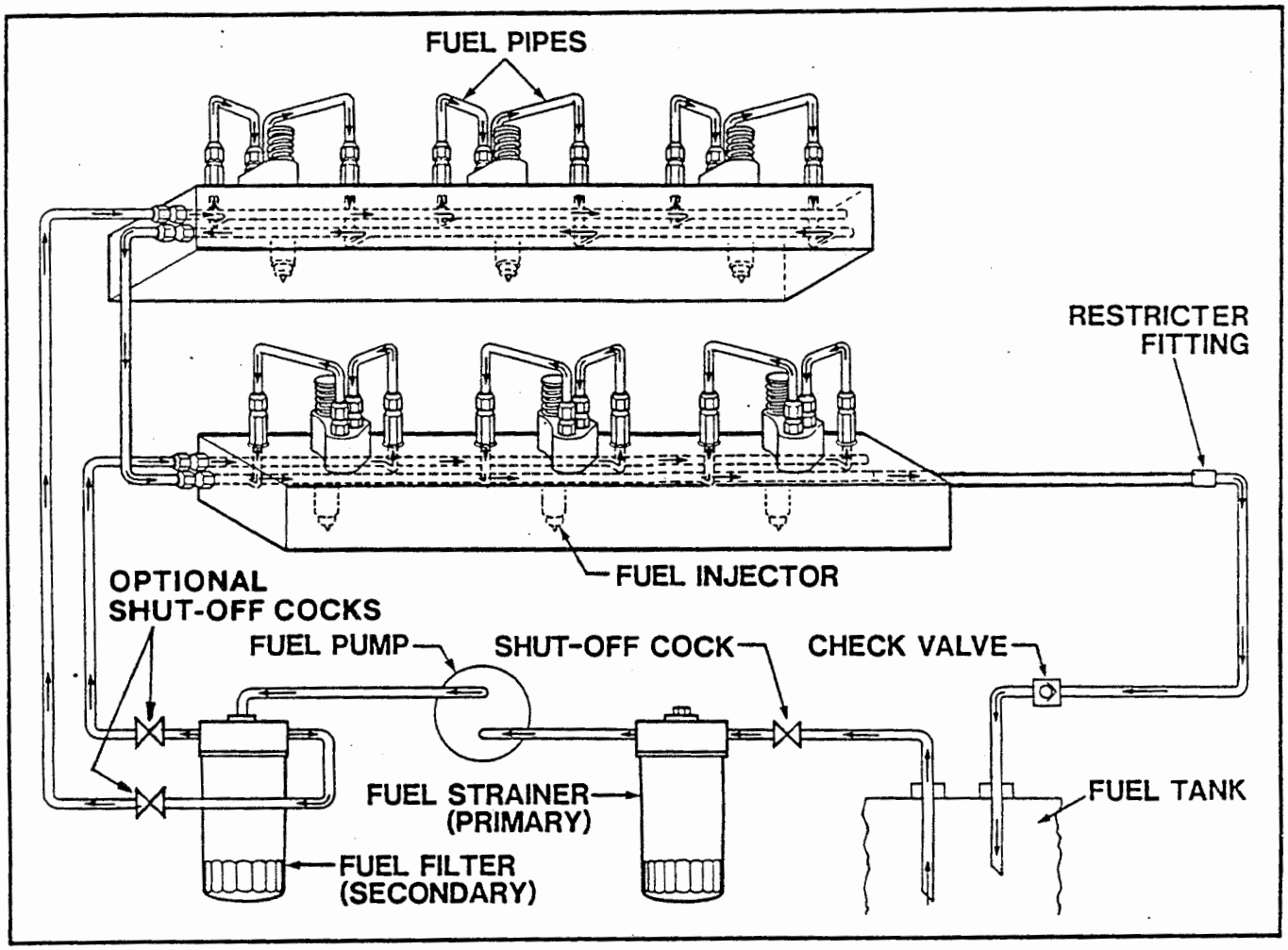


Figure 9-1. Fuel System.

FUEL SYSTEM

The fuel system consists of a fuel tank, fuel lines, filter, strainer, pump, fuel manifolds (integral in cylinder heads), fuel pipes (inlet and outlet), and injectors. The fuel system is illustrated in figure 9-1. For further information on engine fuel system components, consult the appropriate Detroit Diesel Engine Service Manual.

Fuel is drawn from the tank, through the primary filter entering the fuel pump at the inlet side. The fuel is then forced through the secondary filter into the manifold and then to the inlet side of the injectors. Surplus fuel returns from the outlet side of the injectors to outlet fuel pipes, into the return manifold and back to the fuel tank. The accelerator linkage connects the accelerator pedal to the governor. Engine speed is controlled through the governor; details may be found in Detroit Diesel Engine Service Manuals.

DIESEL FUEL

The quality of fuel oil used for high-speed diesel engine operation is a very important factor in obtaining satisfactory engine performance, long engine life, and acceptable exhaust emission levels.

Detroit Diesel Allison designs, develops and manufactures commercial diesel engines to operate on diesel fuels classified by the ASTM as Designation D-975 (grades 1-D and 2-D). These grades are very similar to grades DF-17 DF-2 of Federal Specifications VV-F-800.

Burner fuel (furnace oils or domestic heating fuels) generally require an open flame for satisfactory combustion. The ignition quality (cetane rating) of burner fuel (ASTM D-396) is poor compared to diesel fuels (ASTM D-975).

In some regions, however, fuel suppliers may distribute one fluid that is marketed as either diesel fuel (ASTM D-975) or domestic heating fuel (ASTM D-396) sometimes identified as burner, furnace or residential fuel. Under these circumstances, the fuel should be investigated to determine whether the properties conform with those indicated in the Fuel Oil Selection Chart (figure 9-2).

TYPICAL APPLICATION	GENERAL FUEL CLASSIFICATION	BOILING POINT (MAX.)	CETANE NO. (MIN.)	SULFUR CONTENT (MAX.)
City Buses	No. 1-D	550°F (288°C)	45	0.30%
All Other Applications	Winter No. 2-D Summer No. 2-D	675°F 675°F (357°C)	45 40	0.50% 0.50%

Figure 9-2. Fuel Oil Selection Chart.

Specification or Classification Grade	VV-F-800 DF-1	ASTM D-975 1-D	VV-F-800, DF-2		ASTM D-975 2-D
			North America	Other	
Flash Point, min.	38°C 100°F	38°C 100°F	52°C 125°F	56°C 133°F	52°C 125°F
Carbon Residue (10% residuum), mass % max.	0.15	0.15	0.35	0.20	0.35
Water & Sediment, % by vol. max.	—	0.05	—	—	0.05
Ash, % by wt. max.	0.01	0.01	0.01	0.02	0.01
Distillation Temperature, 90% by vol. recovery, min.	—	—	—	—	282°C 540°F
max.	288°C 550°F	288°C 550°F	338°C 640°F	357°C 675°F	338°C 640°F
End Point max.	330°C 626°F	—	370°C 698°F	370°C 698°F	—
Viscosity					
Kinematic, cSt, min. @ 40°C	1.3	1.3	1.9	1.8 @ 20°C.	1.9
Saybolt, SUS, min. @ 100°F	—	—	—	—	32.6
Kinematic, cSt, max. @ 40°C	2.9	2.4	4.1	9.5 @ 20°C.	4.1
Saybolt, SUS, max. @ 100°F	—	34.4	—	—	40.1
Sulfur, mass % max.	0.50	0.50	0.50	0.70	0.50
Cetane No., min.	45	40	45	45	40

Figure 9-3. Federal Specifications and ASTM Diesel Fuel Properties.

The Fuel Oil Selection Chart will also serve as a guide in the selection of the proper fuel for various applications. The fuels used must be clean, completely distilled, stable, and non-corrosive. Distillation range, cetane number, sulfur content, and cloud point are four of the most important properties of diesel fuels that must be controlled to insure satisfactory engine operation. Engine speed load and ambient temperature all influence diesel fuel selection with respect to distillation range and cetane number.

During cold weather engine operation, the cloud point (temperature at which wax crystals begin to form in diesel fuel) should be 10°F (0°C) below the lowest expected fuel temperature in order to prevent clogging of the fuel filters by wax crystals.

A reputable fuel oil supplier is the only one who can assure you that the fuel you receive meets the distillation end point, cetane number, sulfur content, and cloud point property limits shown in the Fuel Oil Selection Chart. The responsibility for clean fuel that meets Detroit Diesel Allison specifications lies with the fuel supplier as well as the operator.

At temperatures below 32°F (0°C) particular attention must be given to cold weather starting aids for efficient engine starting and operation.

Numerous fuels meeting the properties shown in Fuel Oil Selection Chart (figure 9-2) may be used in Detroit Diesel engines. Figure 9-3 shows some of the alternate fuels (some with sulfur and/or cetane limits) that have been used in Detroit Diesel engines. Among these are No. 1 and No. 2 diesel fuels, kerosene, aviation turbine (jet) fuels, and burner fuels.

Fuel selected should be completely distilled material. That is, the fuel should show at least 98% by volume recovery when subjected to ASTM D-86 distillation. Fuels marketed to meet Federal Specification VV-F-800 (grades DF-1 and DF-2) and ASTM Designation D-975 (grades 1-D and 2-D) meet the completely distilled criteria. The differences in properties of VV-F-800 and ASTM D-975 fuels are shown in figure 9-3.

Fuel oil should be clean and free of contamination. Storage tanks and stored fuel should be inspected regularly for dirt, water or water-emulsion sludge, and cleaned if contaminated. Storage instability of the fuel can lead to the formation of varnish or sludge in the tank. The presence of these contaminants from storage instability must be resolved with the fuel supplier.

PROPOSED ASTMD D-975, GRADE 3-D

TMC/MCI does not recommend the use of proposed grade 3-D diesel fuel in any of its engines. This grade of fuel was proposed, but not accepted by the ASTM.

The grade 3-D which was proposed is undesirable in that it possesses poor ignition quality (i.e. lower cetane); allows greater sulfur content (up to 0.7% by weight); allows the formation of more carbon deposits (Conradson carbon residue); and allows the blending of heavier, more viscous boiling point fractions that are difficult to burn. The latter tend to increase combustion chamber deposits. This type of fuel usually manifests poor cold weather properties (wax formation tendencies). In addition, the poor ignition quality adversely affects noise and emission levels.

DRAINED LUBE OIL IN DIESEL FUEL

TMC/MCI does not recommend the use of drained lubricating oil in diesel fuel. Furthermore, Detroit Diesel Allison will not be responsible for any detrimental effects which it determines resulted from this practice.

ALCOHOL, DIESOHOL, GASOHOL AND GASOLINE IN DIESEL FUEL

Very small amounts of isopropyl alcohol (isopropanol) may be used to preclude fuel line freeze-up in winter months. No more than one pint of isopropyl alcohol should be added to 125 gallons of diesel fuel for adequate protection.

CAUTION: Commercially marketed diesohol or gasohol or gasoline should never be added to diesel fuel. An explosion and fire hazard exists if these blends are mixed and/or burned.

POLICY ON FUEL ADDITIVES

TMC/MCI does not recommend or support the use of any supplementary fuel additives. These include all products marketed as fuel conditioners, smoke suppressants, masking agents, deodorants, and tune-up compounds.

NOTE: TMC/MCI warranty applicable to Detroit Diesel engines provides in part that the provisions of such warranty shall not apply to any engine unit which has been subject to misuse, negligence or accident. Accordingly, malfunctions attributable to neglect or failure to follow the manufacturer's fuel recommendations may not be within the coverage of the warranty.

FUEL SULFUR

The sulfur content of the fuel should be as low as possible to avoid premature wear, excessive deposit formation, and minimize the sulfur dioxide exhausted into the atmosphere. Limited amounts can be tolerated, but the amount of sulfur in the fuel and engine operating conditions can influence corrosion and deposit formation.

All diesel fuels contain a certain amount of sulfur. Too high a sulfur content results in excessive cylinder wear. For most satisfactory engine life, fuels containing less than 0.5% sulfur should be used.

The detrimental effect of burning high sulfur fuel is reflected in Detroit Diesel lube oil change interval recommendations. Detroit Diesel recommends that the Total Base Number (TBN-ASTM D-664) of the lube oil be monitored frequently and that the oil drain interval possibly reduced. Consult the Fuel Oil Selection Chart (figure 9-3).

NOTE: TMC/MCI recommends the use of No. 1-D diesel fuel in all applications; however, No. 2-D is acceptable.

DISTILLATION END POINT

Fuel can be burned in an engine only after it has been vaporized. The temperature at which fuel is completely vaporized is described as the distillation end point (ASTM D-86). The distillation (boiling) range of diesel fuels should be low enough to permit complete vaporization at combustion chamber temperatures.

Combustion chamber temperature depends on ambient temperature, engine speed, and load. Poor vaporization is more apt to occur during severely cold weather, prolonged engine idling and light load operation. Therefore, engines will show better performance operating under these conditions when lower distillation end point fuels are used. Consult the Fuel Oil Selection Chart (figure 9-2).

IGNITION QUALITY — CETANE NUMBER

There is a delay between the time the fuel is injected into the cylinder and the time that ignition occurs. The duration of this delay is expressed in terms of cetane number (rating). Rapidly ignited fuels have high cetane numbers (50 or above). Slowly ignited fuels have low cetane numbers (40 or below). The lower the ambient temperature, the greater the need for a high cetane fuel that will ignite rapidly.

Difficult starting may be experienced if the cetane number of the fuel is too low. Furthermore, engine knock and puffs of white smoke may be experienced during engine warm-up especially in severely cold weather when operating with a low cetane fuel. If this condition is allowed to continue for a prolonged period, harmful deposits will accumulate within the combustion chamber. Consult the Fuel Oil Selection Chart (figure 9-2).

FUEL SYSTEM PRIMING

There can be a problem restarting an engine after it has run out of fuel. After the fuel is exhausted from the tank, it is pumped from the primary filter and sometimes partially removed from the secondary filter before the fuel supply is insufficient to sustain engine firing. The primary filter and secondary filter must be free of air in order for the system to provide adequate fuel for the injectors.

When the engine runs out of fuel, the following procedures must be performed before restarting.

1. Fill the fuel tank with the recommended fuel. If only partial filling is possible, add a minimum of 10 gallons (38 liters).
2. To prime or purge the system, disconnect the line from the fuel pump, then apply fuel under pressure (60-80 psi — 413-552 kPa) to the inlet of the secondary filter. If the system is to be purged of air as well, allow fuel to flow freely from the fuel return line until a solid stream without air bubbles is observed.
3. Reconnect the fuel line, start the engine and check for leaks.

NOTE: It may be necessary to remove a valve rocker cover and loosen a fuel pipe nut in order to bleed any trapped air from the fuel system. Ensure that the fuel pipe nut is retightened before installing the rocker cover.

FUEL FLOW CHECK

A fuel flow check may be made by disconnecting the flexible fuel return line from the fitting at the rear bulkhead. Place the end of the return line in a convenient receptacle. As fuel must pass through the return line restriction fitting, do not disconnect the line at the bracket on top of the engine.

1. For non-turbocharged engines, start and run the engine at 1200 RPM. A fuel flow of 0.8 gallons (3 liters) per minute is specified with a fuel line restriction fitting having an .080" (.203 mm) spill orifice.
2. For turbocharged engines start and run the engine at 1800 RPM. A fuel flow of 1.4 gallons (5.3 liters) per minute is specified with a fuel line restriction fitting having a .070" (1.78 mm) spill orifice.
3. Dip the end of the return line into the fuel container. Air bubbles rising to the surface indicates that air is being drawn into the fuel system on the suction side of the fuel pump. If air is present, tighten all fuel line connections between fuel tank and fuel pump.

If fuel flow is insufficient for satisfactory engine performance, check for faulty fuel lines, clogged filters or malfunctioning fuel pump.

FUEL TANK REMOVAL

A welded aluminum fuel tank with a capacity of 144 gallons (545 liters) is mounted behind the front axle. Fueling is performed through a door in the body paneling behind the right front wheelhousing. Provisions are made in the body paneling for access to the fuel tank should removal be necessary. A whistle type device is provided to indicate when tank is 95% full.

1. Prior to removal, the fuel tanks should be completely drained. Remove the exterior fuel tank door and the bar that secures the fuel tank in place.
2. Disconnect the feed and return fuel lines. If the coach is equipped with a fuel gauge, disconnect the wire leading to the sender.
3. Ensure that the filler neck is clear, then carefully slide the fuel tank out of the compartment.

NOTE: On coaches without an auxillary fuel tank, it will be necessary to raise the tank approximately ½" (12 mm) to allow the closing plate to clear the cutout in the floor.

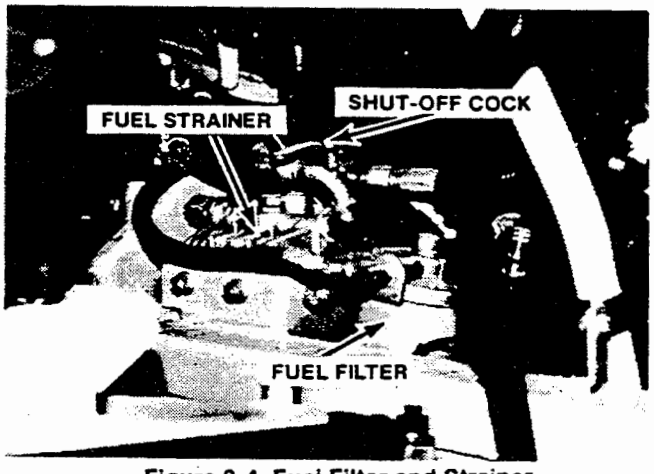


Figure 9-4. Fuel Filter and Strainer.

MC-9 MAINTENANCE MANUAL

FUEL STRAINER AND FILTER

The fuel system is equipped with a filter and strainer for additional protection of the injectors. The filter and strainer and fuel line connections are shown in figure 9-4. Refer to the Detroit Diesel Engine Service Manual for instructions on disassembly, cleaning and other service procedures.

Every 10,000 miles (16,000 km), open the drain at the bottom of the fuel tank to drain off any water or sediment.

The service interval at which the strainer and filter should be changed is determined by operating conditions and cleanliness of fuel used.

Before removing the fuel filter or strainer, close the shut-off cock which is installed at the primary filter inlet (figure 9-4). An optional shut-off cock may also be installed between the fuel pump and the secondary strainer. If present, close it also. Both of these valves are installed to prevent fuel from draining out of the lines while the filters are being serviced. In the case of the optional one, it also prevents the fuel pump from emptying and thereby losing its prime.

To change the strainer or fuel filter, remove by turning counterclockwise. To replace, turn on clockwise and tighten 2/3 of a turn after contacting gasket. New gaskets should be used with each replacement.

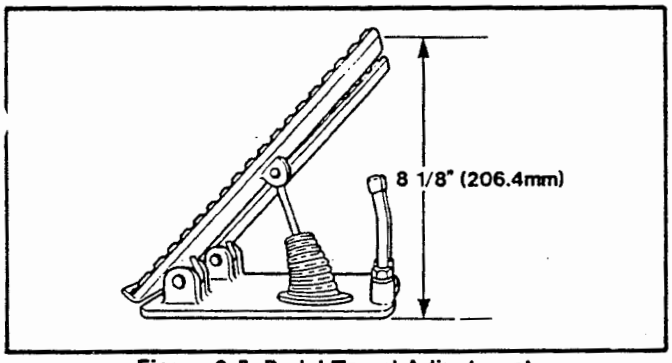


Figure 9-5. Pedal Travel Adjustment.

ACCELERATOR AND BRAKE PEDAL TRAVEL

NOTE: The following accelerator adjustment procedure is applicable only to a coach with a non-electronically controlled engine (non-DDEC).

1. Remove the spare tire and inspection panel from the tire compartment.
2. Shorten the accelerator bell crank rod until the pedal reaches 8⅛" (206.4 mm). Measure from the floor to the underside tip of pedal. See figure 9-5.

CAUTION: After shortening the accelerator rod, check for excess threads protruding in the clevis and binding on the lever. Excess threads must be cut off if they interfere with the lever.

NOTE: The pedal stop must be installed with the bend as shown in figure 9-5. The tip of the stop must also line up with the recess on the underside of the pedal.

3. Adjust the brake pedal rod as required until the brake pedal height is the same as the accelerator pedal height.

NOTE: The brake pedal must be adjusted to ensure the application valve is being fully applied. Care must be taken not to allow the roller on the application valve to go over center.

After the pedal heights have been adjusted, the accelerator pedal stop must be adjusted as follows to ensure full fuel position of governor lever:

4. Disconnect the transmission modulator cable at governor bell crank (coaches equipped with automatic transmission).
5. Depress the accelerator pedal and adjust the stop to ensure full travel.
6. While the accelerator is fully depressed, adjust the modulator cable (automatic transmission) by pulling it out to its full limit of travel and adjusting the ball joint so that the bolt will engage with the hole in the governor bell crank while the cable is fully extended and the accelerator fully depressed.
7. With the engine at fast idle, depress the accelerator pedal fully, engine RPM should not rise. If RPM increases, the spring link is completely compressed to a solid link by too much pedal travel. In this case, the pedal stop should be raised.

TRANSMISSION MODULATOR VALVE

A single action, pneumatic cylinder modulator valve mounted on the transmission is used in the air throttle control system. It provides the transmission with a signal proportional to the throttle position to control the transmission shift pattern.

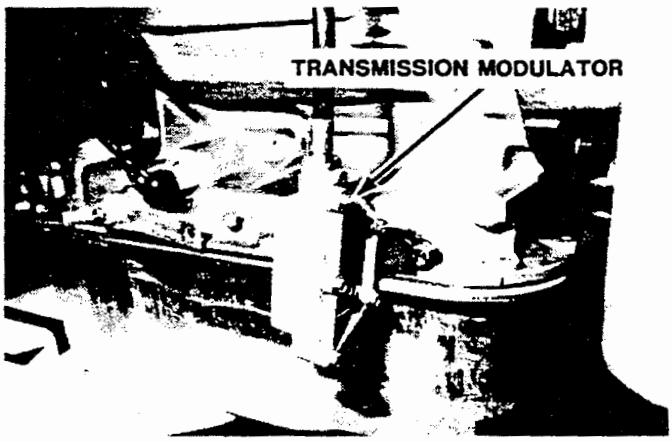


Figure 9-6. Modulator Valve

When the accelerator treadle is depressed, the throttle control moves toward the full throttle position. Simultaneously, the piston in the modulator valve extends and provides the throttle valve with a modulating force. When the pedal is released and the throttle returns to idle, modulating force drops to zero.

The modulator valve is non-serviceable and if its condition is suspect, it must be replaced as a unit.

MC-9 MAINTENANCE MANUAL

AIR CLEANER (OIL TYPE)

DESCRIPTION AND OPERATION

Some earlier MC-9 coaches are equipped with a heavy duty oil bath air cleaner. Located in the engine compartment, the air cleaner is accessible through the left hand side engine compartment service door.

Air flows through the left hand radiator and enters the cleaner through the top inlet. As the air passes through the filter element, dirt is trapped in the oil. The oil is condensed as it passes back up through the air cleaner body so that only clean dry air passes through the outlet to the engine. The condensed oil returns to the cup where the dirt settles and the clean oil is recirculated.

MAINTENANCE

Efficient engine operation depends on proper maintenance and service. Radiator shutters and blower dampers must work in conjunction with each other. If these assemblies have the air supply closed off, a decided increase in fuel consumption can occur. Periodic checks should be made to determine that no leaks are present in the connections and duct work in the system. Otherwise, dust-laden air may bypass the air cleaner and enter the engine.

The intervals at which the air cleaner should be serviced will vary, depending on the amount of dust present in the air, service conditions, seasons, etc. However, the service intervals should be frequent enough to ensure that no appreciable amount of sludge builds up in the air cleaner cup.

In areas where conditions are ideal, servicing the air cleaner every 150 hours or 5,000 miles (8,000 km) is sufficient, whereas in other regions it may be necessary to service the air cleaner daily. In all cases the oil cup should be serviced when ½" (12.5 mm) of sludge has been collected in the bottom of either of the two oil cups.

AIR CLEANER COMPONENTS

The air cleaner is comprised of four separate units that work in conjunction with each other to clean the air.

The body assembly filters the air and condenses the oil from the air stream ensuring that only clean dry air enters the engine.

The removable element assembly extracts a major part of the dust from the air stream, decreasing the load to the fixed wire element. The element is removable for cleaning, thus reducing the need for frequent body removal and fixed element service.

The inner cup acts as a baffle in directing oil-laden air to the element. It also controls the amount of oil in circulation and meters the oil flow to the element.

The oil cup supports the inner cup and the removable element assembly. It is also a reservoir for oil and a settling chamber for dirt.

OIL CUP SERVICING

At regular intervals, as outlined previously, the air cleaner should be serviced as follows:

1. Support the bottom of the air cleaner assembly so that it does not drop when the clamps are detached.
2. Detach the two side clamps, remove the bottom oil cup and remove the element assembly.
3. Pour out the oil and remove the inner cup. Remove all sludge and wipe clean.
4. Reassemble the inner cup in the outer cup and refill them both to the indicated oil level.

NOTE: MCI/TMC recommends the same oil specified for the engine crankcase for use in the air cleaner.

CAUTION: Do not overfill or underfill the oil cups. Overfilling causes a lack of capacity, whereas underfilling will result in a lack of efficient air cleaning.

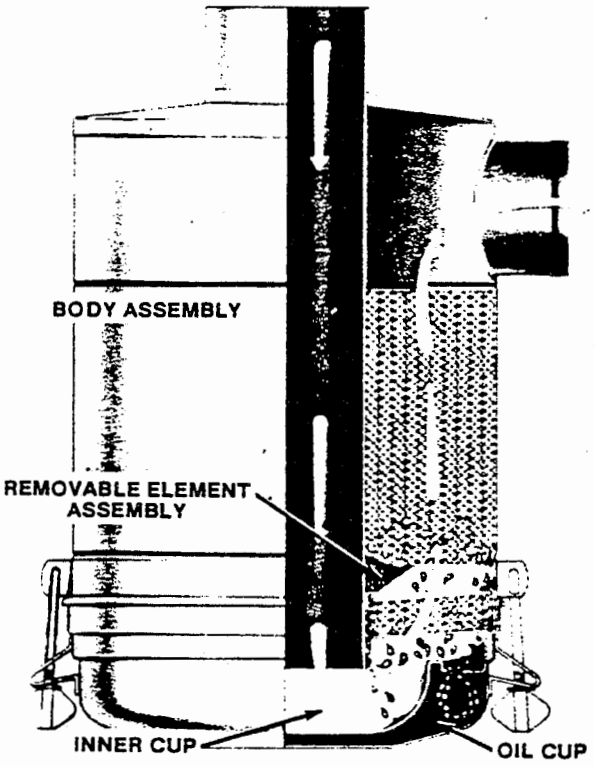


Figure 9-6A. Oil Type Air Cleaner.

REMOVABLE ELEMENT SERVICING

The first step in servicing the removable element assembly is to hold a strong light as close to the element as possible. An even, bright pattern of light through the wire element means that the element is clean. A dull pattern of light means that the element is partially plugged with dirt and should be cleaned or replaced. To clean the air cleaner, proceed as follows:

1. Wash the element thoroughly with solvent and blow dry with compressed air.
2. Inspect the lower portion of the air cleaner body and the center tube each time the oil cup is serviced.

If there is any sign of sludge build-up or plugging, the body should be removed and cleaned. At least once a year the body should be removed and serviced in the following manner:

1. Remove the oil cups and removable element assembly.
2. Check and clean the center tube.
3. Spray solvent through the air outlet with sufficient force and volume to produce a hard, even stream out the bottom of the body. Reverse flushing in this manner will remove all dirt from the fixed element.

CAUTION: Always cover the engine air intake while the air cleaner is being serviced.

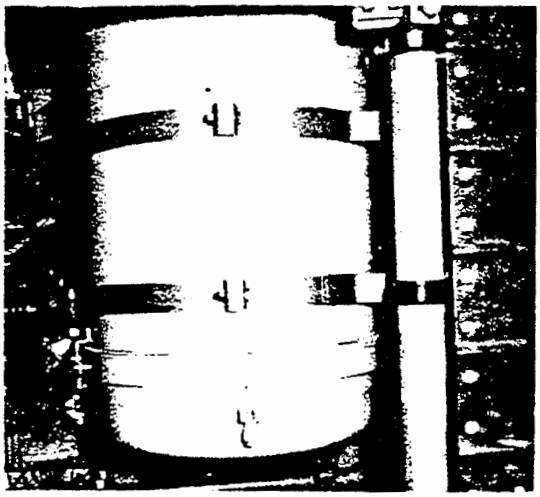


Figure 9-6B. Oil Type Air Cleaner Installed.

GENERAL SERVICING

The air cleaner should be routinely inspected for leaks. A damaged air cleaner can seriously affect the performance and life of the engine. The following simple service practices are easily made while the engine is being serviced:

1. Inspect all connections for mechanical tightness and be sure that the air cleaner outlet port is not fractured.
2. If the air cleaner has been dented or damaged, inspect all connections immediately.
3. In the event that adjustments do not correct air leakage, replace necessary parts.

FILTER INSPECTION CHECK-OFF

Check the following items at regular intervals:

1. Mounting Bolts and Brackets
2. Air Cleaner Body Damage
3. Restriction Indicator Connection (Leak)
4. Body to Inlet Joint (Damage)
5. Body to Outlet Joint (Leak)
6. Connections to Engine (Leak, Damage)
7. Filter Element (Dirty, Damage)

AIR CLEANER (DRY TYPE)

DESCRIPTION AND OPERATION

The later MC-9 coach is equipped with a dry-type air cleaner with a replaceable filter located at the rear of the coach. The air cleaner is accessible through the left hand side engine compartment service door.

Air flows through the left hand radiator and enters the air cleaner through the top inlet. As air passes through the air cleaner, dirt is deposited in the filter element, allowing clean air to flow through the outlet into the engine.

INSPECTION

A routine inspection of the air induction system will help to prolong engine life.

The air filter restriction indicator (see figure 9-7) should be checked daily to ensure that the filter element does not require changing.

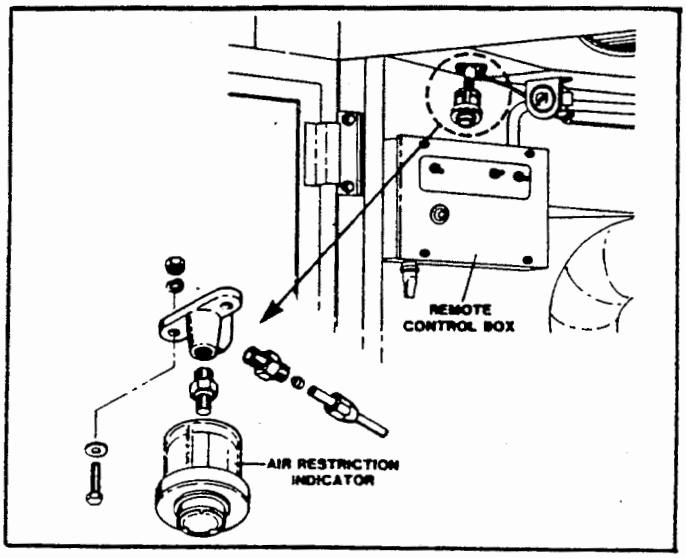


Figure 9-7. Restriction Indicator.

MC-9 MAINTENANCE MANUAL

At each engine oil change the air cleaner should be inspected as follows:

1. Check for proper mounting of air cleaner assembly.
2. Check the air cleaner body for cracks and dents, and ensure that the cover is fastened securely.
3. Check the air cleaner clamps at the inlet and outlet ports to ensure that there are no air leaks.

AIR CLEANER REMOVAL/INSTALLATION

1. Loosen the clamps at the air cleaner inlet and outlet ports and disconnect the line from the air cleaner to the air filter restriction indicator.
2. Support the bottom of the air cleaner so that it does not drop when the mounting bands are loosened.
3. Remove the capscrews and nuts from the bands and remove the air cleaner from the coach.

To install the air cleaner, reverse the removal procedure. Ensure that all mounting hardware is fastened tightly and that all air lines are properly connected, preventing the entry of dirt.

REPLACING THE FILTER ELEMENT

1. Remove the air cleaner assembly, as outlined previously.
2. Remove the twelve nuts that secure the air cleaner cover and remove the cover and filter element.
3. Wipe the inside of the air cleaner body, as well as the inlet and outlet ports, with a clean damp cloth.
4. Install the new element, ensuring that the open end of the element is facing the inlet port on the air cleaner cover.
5. Install the cover and tighten the twelve nuts to 7 ft. lbs. ±1 ft. lb. (95 Nm±1.3 Nm). Follow the recommended tightening sequence.

NOTE: Before installing the cover, check the condition of the gasket and replace if necessary.

6. Install the air cleaner into the coach.

TROUBLESHOOTING

Short Element Life

Air cleaner inlet restricted. Ensure that no foreign material is blocking inlet pipe.

Air filter element too small. Replace element with one of correct size as per Parts Manual.

Dirty element. Replace.

Damaged or improperly calibrated restriction indicator. Replace restriction indicator.

Airborne Contaminants Entering Engine

Damaged element. Check the element for dents before installing. Never use an element which shows obvious signs of damage.

Leaky gaskets. Before reassembly, ensure gaskets will seal correctly. Look for dust trails which indicate leaky gaskets. Replace any brittle or damaged gaskets.

Leaky air inlet. Examine air inlet for cracks or loose flange joints.

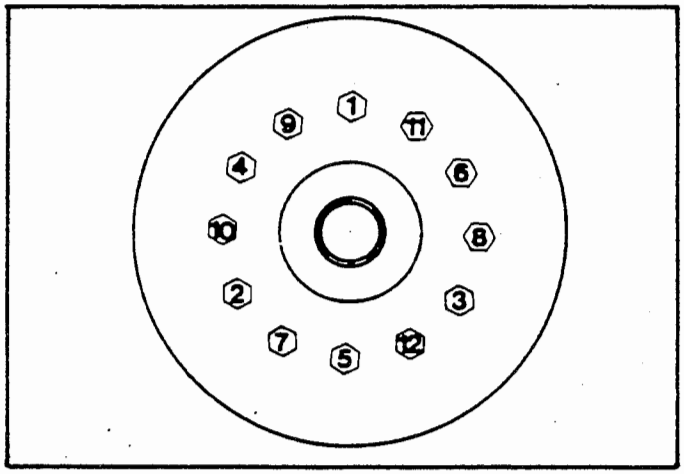


Figure 9-8. Cover Nut Tightening Sequence.

GENERAL CAUTIONS

A. Never operate the vehicle without an element in the air filter assembly.

B. Use only original equipment filter elements.

C. Whenever element has been removed from filter body, clean inside of filter body with a clean, damp cloth.

D. Do not ignore the warning given by the air restriction indicator. To do so is to invite serious engine damage.

E. Store new elements in a protected area free from dust and damage.

F. Use the proper element when replacing element in filter.

G. Dirty elements should not be washed or reused.

CRUISE CONTROL (OPTION)

Cruise control is a driver controlled, automatic speed control system designed for use on heavy duty highway vehicles.

The system incorporates the following features:

A. Set/Resume - permits vehicle speed to be set or to resume a previously set speed after disengagement.

B. Accelerate/Coast - permits vehicle speed increase or decrease with control switches.

C. Top speed, Set limit - prevents cruise control use above a preset maximum vehicle speed.

The cruise control system may be turned on at any time; however, vehicle speed must be greater than approximately 20 mph (32 kmh) before the speed can be set. (The 20 mph minimum speed may vary due to tire size and rear-end ratio.)

CAUTION: The cruise control system should not be used in heavy traffic or when road surfaces are slippery.

OPERATION

Turning The System On - Flip the Cruise Control switch on.

Setting The Vehicle Speed — Accelerate vehicle to desired speed above approximately 20 mph (32 kmh) and momentarily depress and release the SET side of the Set/Resume switch release accelerator pedal. Cruise control system will not accept speed settings below approximately 20 mph (32 kmh).

Increasing Vehicle Speed Setting — A previously selected set speed may be increased by one of two methods:

a. Depress and hold Resume switch until desired speed is obtained. While Resume switch is depressed, vehicle speed will increase by one mph per second. When switch is released, new speed is set.

b. Depress accelerator pedal until desired speed is obtained and depress Set switch. When driving with cruise control in use, speed may be increased for passing, etc., by depressing accelerator in normal procedure. When foot is removed from accelerator pedal, cruise control will return vehicle to set speed.

1. Decreasing Vehicle Speed Setting — There are two methods of decreasing a previously selected speed setting:

a. Lightly depress brake and allow vehicle to coast to desired speed and depress and release Set switch. Depressing the brake pedal slightly disengages the system.

b. Depress and hold the SET side of the Set/Resume switch until the desired speed is obtained and release Set switch. While the Set switch is set, the vehicle will "coast" down in speed. When the switch is released, the system will be set at the new speed.

Shifting Gears (Standard Transmission) — With cruise control in use, the transmission may be shifted in the normal procedure without disengaging cruise control. When the clutch pedal is depressed, the cruise control will disengage, allowing the shift to be completed. When the clutch is released, the cruise control will engage; adjusting engine rpm to the new gear selection in order to maintain the set speed, provided the vehicle speed has not dropped below approximately 20 mph (32 kmh).

Resuming Automatic Operation After Brake Application — Accelerate vehicle to a speed above approximately 20 mph (32 kmh) and depress and release Resume switch. Resume feature will automatically return the vehicle speed to the prior to the brake application and maintain that speed. The Resume feature will not operate if:

a. Vehicle speed is below approximately 20 mph (32 kmh).
b. Cruise control system has been turned off.
c. Vehicle ignition or ON/OFF switch has been turned off.

Cancelling Automatic Operation — Cancelling the cruise control automatic operation is accomplished by one of four methods:

NOTE: Any objectionable vehicle motion when system is disengaged can be minimized by placing foot on accelerator before disengaging cruise control.

a. Turn off the ON/OFF switch.
b. Turn the ignition or kill switch off.

NOTE: a & b cancels automatic operation and Resume feature will not operate.

c. Make a slight brake application.
d. Slow vehicle speed to 20 mph (32 kmh) below the "set speed."

NOTE: c & d cancels automatic control but Resume feature can be used if automatic operation is desired.

MC-9 MAINTENANCE MANUAL

COMPONENT DESCRIPTION - NON-DDEC II INSTALLATION (EXCEPT SWITCH PANEL ON DASH)

The cruise control system is a combination of the following pneumatic and electronic components:

CONTROL MODULE — a digital microcomputer that serves as the control center for the cruise control system. The function of the module is to process vehicle speed information and control vehicle speed, or throttle position, commanding the solenoids to either increase or decrease air pressure to the air cylinder.

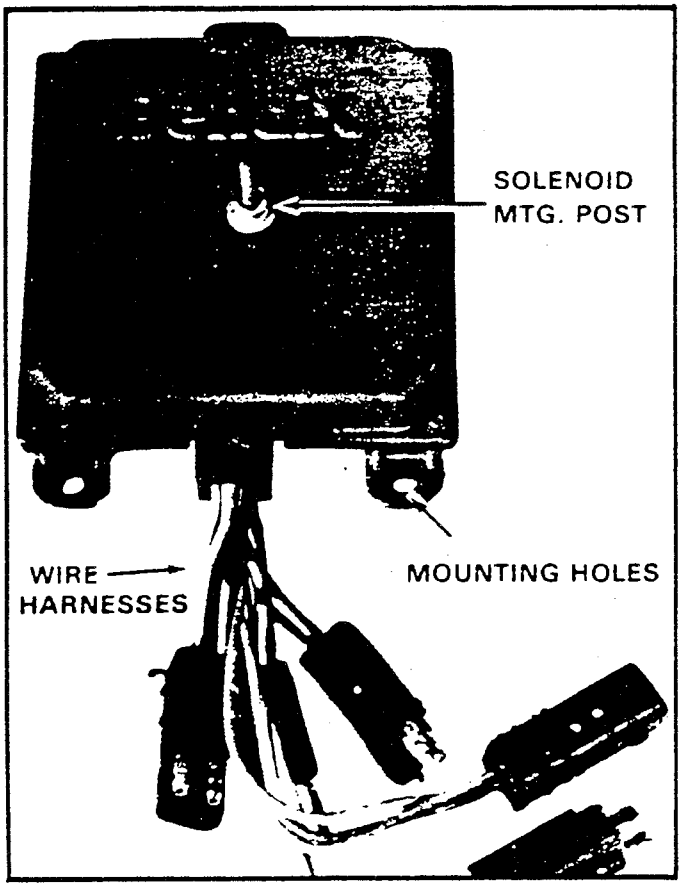


Figure 9-9. Control Module.

The control module is comprised of the electronic package, housed in a 5" x 7" (12.7 x 17.8 cm) steel case. See figure 9-9.

SOLENOID ASSEMBLY — mounted directly to the module case, the assembly employs two solenoids; one controls the inlet valve, the other controls the exhaust valve (figure 9-10).

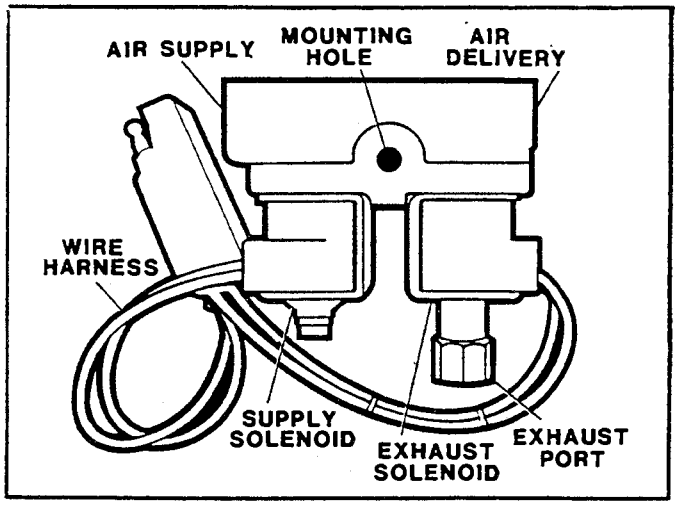


Figure 9-10. Solenoid Assembly.

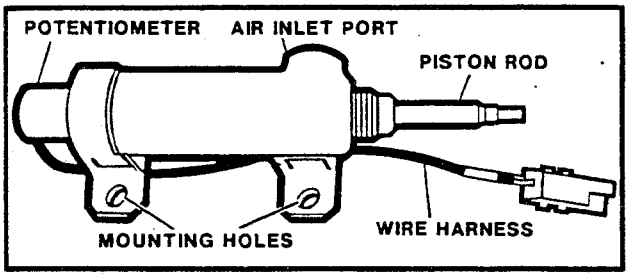


Figure 9-11. Air Cylinder.

AIR CYLINDER — a die cast aluminum, piston type air cylinder which controls the throttle position while cruise control is in operation. A potentiometer located in the end of the cylinder monitors and reports throttle position to the control module via the connecting wiring harness. The cylinder is approximately two inches in diameter and nine inches long (5.1 x 22.9 cm) with a single ¼" (6.35 mm) NPTF air connection port. The end of the cylinder body and piston rod are threaded to accept the throttle cable assembly. Two mounting lugs are provided. Refer to figure 9-11.

PRESSURE REDUCING VALVE — (60 psi (414 kPa) delivery pressure) is installed between the vehicle air supply and the solenoid assembly. The 60 psi air pressure is necessary for proper operation of the solenoid assembly. (Figure 9-20 shows all components of the cruise control system.)

STOP LAMP SWITCH — connected to the control module. In addition to lighting the vehicle stop lights, it signals the control module to disengage the cruise control when the service brakes are applied.

MC-9 MAINTENANCE MANUAL

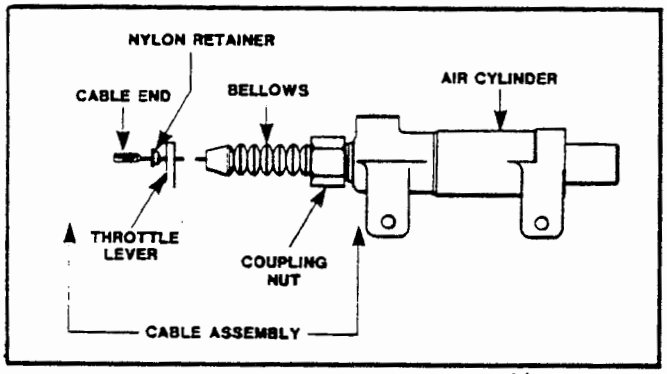


Figure 9-12. Throttle Cable Assembly.

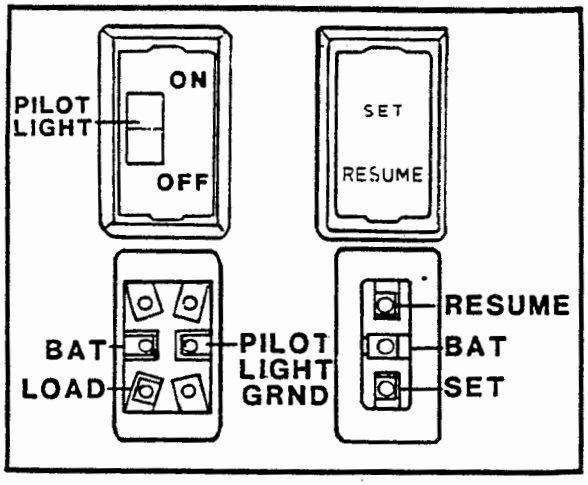


Figure 9-13. Cruise Control Switch Leg.

TR-3 INVERSION VALVE — installed in the foot valve service delivery line and exhausts air from the air cylinder each time a service brake application is made. This serves as a pneumatic back-up disengagement system and assures that no single point failure, either electrical or pneumatic, will allow the engine to overspeed after a brake application is made.

THROTTLE CABLE ASSEMBLY — links the air cylinder to the engine throttle control. It permits the pull developed by the air cylinder to be transmitted to the engine throttle. The cable incorporates a threaded nut for attachment to the air cylinder. See figure 9-12.

CONTROL SWITCH PANEL — Two electrical switches, located within easy reach of the driver, are used to control the system (figure 9-13). The On/Off switch supplies electrical power to the system and the Set/Resume switch controls the vehicle speed set and speed resume function.

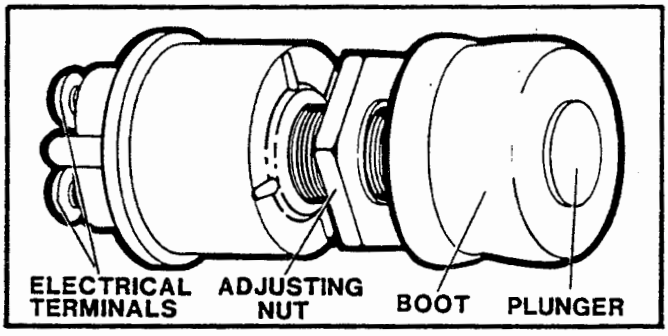


Figure 9-14. Clutch Switch.

CLUTCH SWITCH — utilized on vehicles with standard transmission to disengage the cruise control system each time the clutch is depressed. The cruise control will re-engage at the previously selected speed when the clutch is released. This permits the driver to shift gears in the normal manner (figure 9-14).

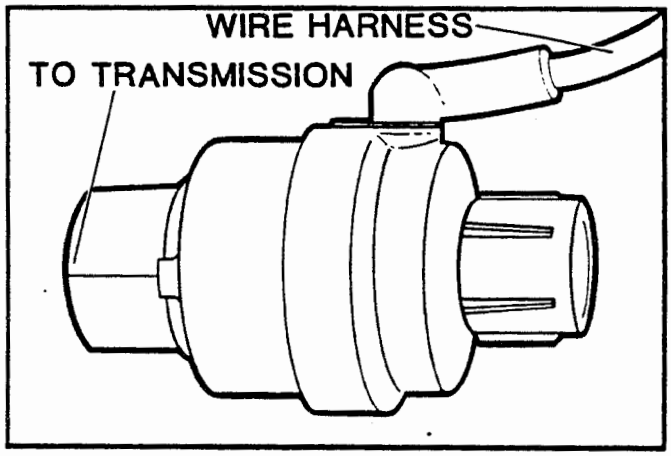


Figure 9-15. Speed Sensor.

SPEED SENSOR — provides vehicle speed information to the control module. It is a unitized module which is installed in the transmission speedometer output circuit (figure 9-15).

MC-9 MAINTENANCE MANUAL

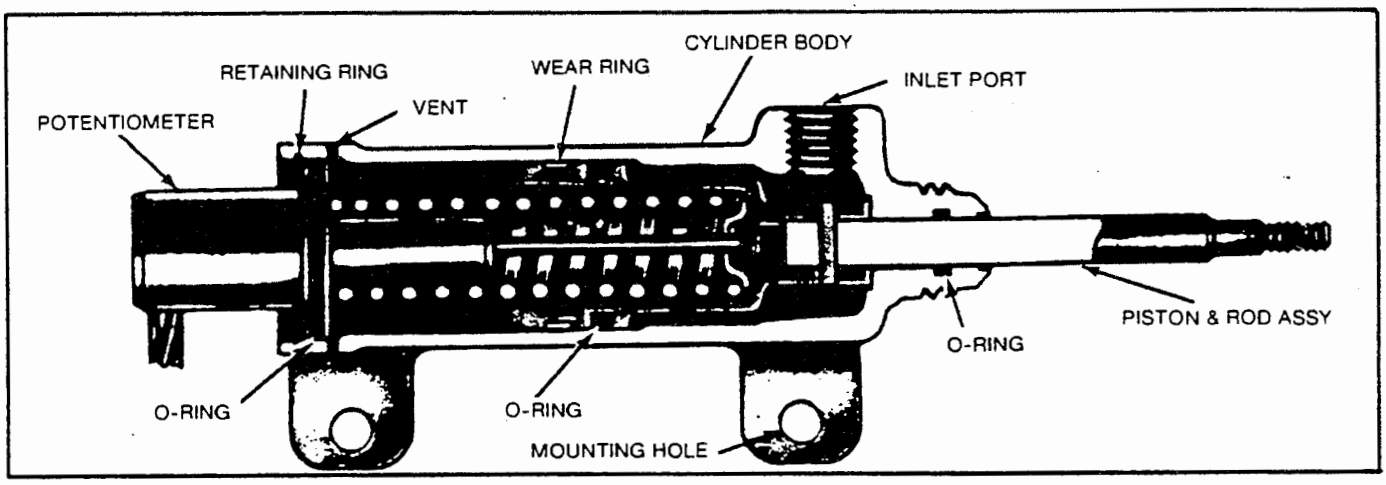


Figure 9-16. Air Cylinder — Sectional.

CRUISE CONTROL PREVENTIVE MAINTENANCE (NON-DDEC)

Every three months, 25,000 miles (40,233 km) or 900 operating hours:

1. Inspect the air cylinder for secure mounting.
2. Remove accumulated grime from the outside of the air cylinder with particular attention to the three body vents (figure 9-16).
3. Remove accumulated grime from the exterior of the solenoid assembly.
4. Visually inspect the throttle cable and cable end for fraying or wear. Replace if necessary.
5. Inspect the throttle cable hardware for secure mounting.
6. Visually inspect the system wiring and connectors for deterioration or wear.
7. Perform the system operation road test.

Every year, 100,000 miles (161,000 km) or 3,600 operating hours, remove, repair or replace and test the following components:

A. Inversion Valve.
B. Reducing Valve.
C. Air Cylinder.
D. Solenoid Assembly.

OPERATING AND LEAKAGE TESTS

NOTE: To properly test the solenoid assembly and air cylinder, remove from the vehicle and bench test. An ohmmeter is required to perform the tests.

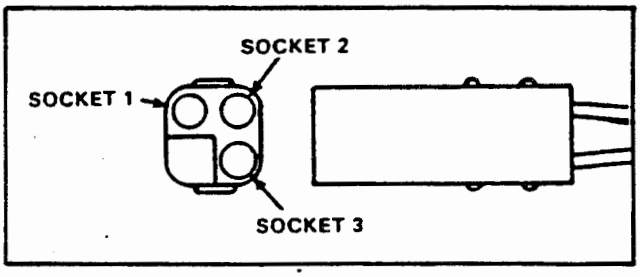


Figure 9-17. Potentiometer Harness Connector.

Refer to figures 9-16 and 9-17.

Release all air pressure from the air cylinder. With an ohmmeter, perform the following tests:

1. Check the resistance between sockets 1 and 3. Resistance should be 3600-4400 ohms.
2. Check the resistance between sockets 2 and 3. Resistance should be 1080-1320 ohms.
3. Check the resistance between sockets 1 and 2. Resistance should be 4320-5280 ohms.
4. Apply air pressure to the air cylinder. With the ohmmeter connected to sockets 2 and 3, slowly raise the pressure from 0-60 psi (414 kPa). Resistance should increase smoothly as the piston strokes. If the meter needle wavers or "jumps," the potentiometer is faulty and must be replaced.

Connect an adjustable air regulator and gauge between an air source and the inlet port of the air cylinder (figure 9-16). Raise and lower the air pressure between 0 and 60 psi (414 kPa) several times, noting that the piston rod (1) extends and retracts smoothly. With 60 (414 kPa) psi applied to the air cylinder, apply a soap solution around the piston rod (1) and the body vents (9). Total leakage should not exceed a one-inch soap bubble in less than five seconds.

The air connections should remain in place when performing the electrical tests.

If the air cylinder does not function as specified or leakage is excessive, it is recommended that it be replaced with a new or remanufactured unit or repaired with OEM parts. (A maintenance kit which contains all necessary parts is available.)

To test the solenoids, a source of power (battery) will be needed. Check to make certain that the battery voltage is 24 volts.

Connect a 60 psi (414 kPa) air source to the supply port and install a gauge in the delivery port.

1. With 60 psi (414 kPa) applied to the supply port, apply a soap solution to the exhaust port. Leakage should not exceed a 1-inch bubble in less than five seconds.

2. Simultaneously, apply positive (+) power to pins 3 and 4, and negative (-) power to terminals or sockets 1 and 2 (figure 9-18). With power applied note that 60 psi (414 kPa) is registered on the gauge installed in the delivery port.

3. Continue to apply power (Step 2) and apply a soap solution to the exhaust port, the exterior of the body and around solenoid coils. Leakage should not exceed a 1-inch bubble in less than five seconds at the exhaust port. No leakage is permitted elsewhere.

4. Remove the electrical power from the solenoid sockets, or pins.

5. Refer to figure 9-18) connect an ohmmeter to:

(a) socket 1 and pin 4 or terminals 1 and 4. Resistance should be 90-110 ohms.

(b) Socket 2 and pin 3 or terminal 2 and 3. (Resistance should be same as in Step a.)

If the solenoid assembly does not test or function as needed, or leakage is excessive, it must be replaced.

Perform the following procedure to remove the air cylinder:

1. Park and secure the vehicle by means other than air brakes on a level surface.

2. Vent air pressure from all reservoirs.

3. Disconnect the throttle cable assembly at the engine throttle lever.

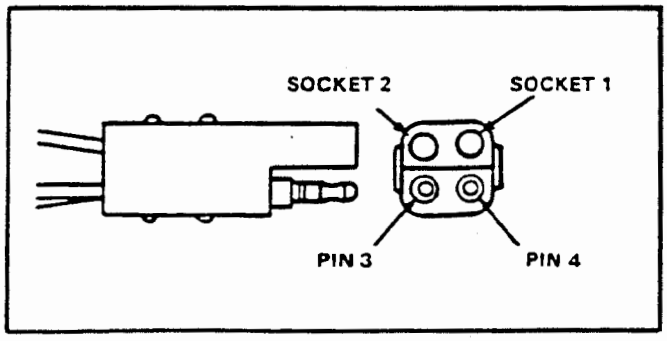


Figure 9-18. Solenoid Assembly Harness Connector.

4. Unscrew the throttle cable coupling nut on the end of the air cylinder throttle cylinder body (8 in figure 9-16).

5. Unscrew the cable nut at the end of the piston and rod assembly (1).

6. Disconnect the air inlet line.

7. Disconnect the electrical connector for the potentiometer assembly (7).

8. Remove the two mounting screws and remove the air cylinder from the vehicle.

NOTE: A maintenance kit (4G-22-141) containing all parts necessary for minor rebuild is available.

To disassemble the CC-5 air cylinder, proceed as follows:

1. Remove and discard retaining ring (5).

2. Remove and retain the potentiometer assembly (7).

CAUTION: Do not apply force to end of potentiometer plunger and spring assembly.

3. Remove and discard O-ring (6) from potentiometer assembly (7).

4. Push the piston and rod assembly (1) out of the body (8).

5. Remove and discard O-ring (3) and wear ring (4) from the piston assembly (1).

6. Remove and discard O-ring (2) from the air cylinder body (8). This is an internal O-ring and will require an O-ring removal tool.

Prior to assembly of the air cylinder, the piston and rod assembly and the body should be cleaned with mineral spirits. Make certain the vent holes (9) in the body (8) are open. Using lubricant 4G-22-140 (Dow Corning 55M furnished in maintenance kit), lubricate all O-rings, O-ring grooves, the piston bore in the body and the rod of the piston assembly. Then follow this procedure:

1. Install O-ring (2) in body (8). Be sure O-ring (2) and the body are well lubricated before installing. Bend the O-ring in half and insert it into the body. Using the "dulled" point of a wooden pencil, push part of the O-ring into the groove in the body (use care not to damage the O-ring). Using the eraser end of the pencil, push the balance of the O-ring into the body groove. The O-ring should slide into the groove.

2. Install O-ring (3) and wear ring (4) on piston and rod assembly (1).

3. Install piston and rod assembly (1) in body (8), taking care not to damage O-rings (2 and 3).

4. Install O-ring (6) on potentiometer assembly (7).

5. Install potentiometer assembly (7) in body (8) and install retaining ring (5). Make sure that retaining ring (5) is completely seated in its groove in the body (8).

6. Perform operating and leakage tests prior to reinstalling the air cylinder assembly.

MC-9 MAINTENANCE MANUAL

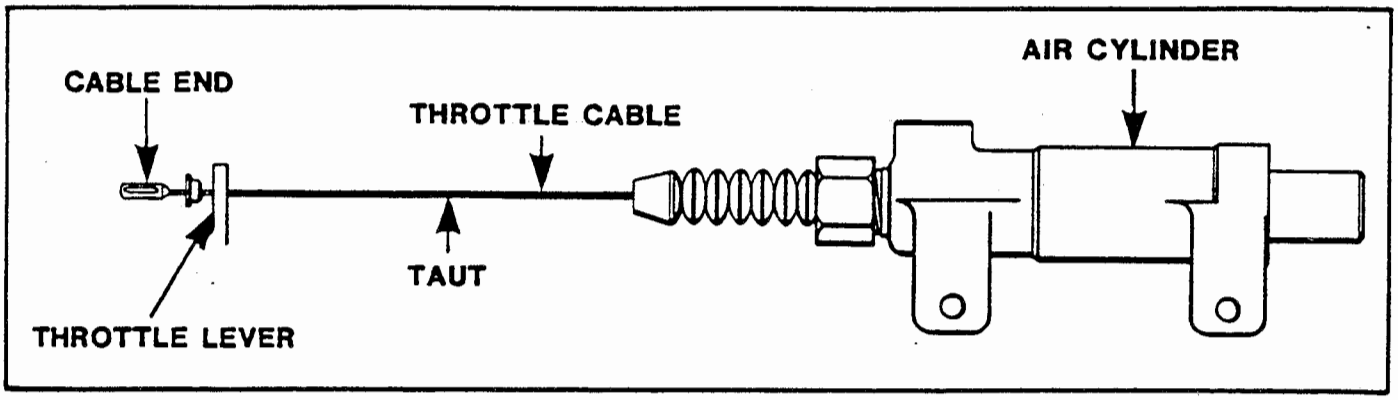


Figure 9-19. Throttle Cable Adjustment.

Installation of the air cylinder is as follows:

1. Install two mounting screws and reconnect the potentiometer (7) electrical connector. Mounting screw torque is not to exceed 125 in. lbs. (14.123 Nm).
2. Reconnect the air line to the cylinder body (8).
3. Reconnect the cable nut to the piston rod assembly (1). Torque not to exceed 100 in. lbs. (11.29 Nm).
4. Reconnect the cable coupling nut to the end of the air cylinder. Torque not to exceed 125 in. lbs. (14.1 Nm).
5. Reconnect the cable assembly at the engine throttle lever. Using the air cylinder mounting screws, move air cylinder and adjust the throttle cable (figure 9-19) so that it is taut when the accelerator pedal is released. Cable nut torque not to exceed 175 in. lbs. (19.772 Nm).

CAUTION: The cable must be taut; however, the engine throttle should remain closed and in the idle position.

SYSTEM ROAD TEST

When the cruise control system or any of its features are not used regularly, the operational check and road test should be performed monthly. If the road test indicates the system is not operating properly, system should not be used until it has been repaired, tested and proven to be operating properly.

Select a road where traffic and weather conditions will safely permit the road test to be performed.

CAUTION: Cruise control should not be used on wet or slippery roads.

1. With a vehicle speed of 40 mph (64 kmh) turn the system on.
2. Activate the Set switch to establish a speed setting greater than 20 mph (32 kmh). Vehicle speed should be maintained within one mph of speed setting.
3. Apply the brake and allow vehicle to coast down to less than 20 mph (32 kmh). Depress and release the Resume switch. The original vehicle speed should not be resumed.

NOTE: On vehicles with standard transmission, cruise control system should temporarily disengage each time clutch is depressed.

4. Accelerate vehicle to 30 mph (48 kmh) and activate Resume switch; vehicle should automatically accelerate to original set speed.
5. When vehicle has reached its set speed of 40 mph (64 kmh) depress the clutch and allow the vehicle to coast to less than 20 mph (32 kmh). Release the clutch. The original vehicle speed should not be resumed.
6. Repeat step 4 and proceed to step 7.
7. Depress and hold Resume switch in. Vehicle speed should increase at approximately 1 mph per second. Relese Resume switch at 50 mph (80 kmh). This should establish a new set speed of 50 mph (80 kmh).
8. Depress and hold Set switch and allow vehicle to coast down to 40 mph (64 kmh) and release switch. This should establish a new set speed of 40 mph (64 kmh).

NOTE: The minimum speed at which the cruise control will function is approximately 20 mph (32 kmh). However, this will vary slightly due to axle ratio, tire size, etc.

TROUBLESHOOTING - NON-DDEC

The purpose of this troubleshooting guide is to assist you to locate the cause of system malfunctions. System malfunction should be confirmed by performing the road test procedure. This will minimize the possibility of unnecessary work due to a lack of understanding of how the system operates.

Before beginning the checks, visually inspect all electrical wiring, connectors, air lines and components for obvious damage, corrosion, etc.

Electrical tests can be performed with a volt-ohmmeter. The electrical tests described in this section are to be performed on the wiring connectors attached to system components and not the connectors leading to the control module. The connectors illustrated in figures 9-20 and 9-21 are connectors leading to system components.

The following component connector identification chart should be of additional help when used in conjunction with figure 9-21.

The system wiring schematic is shown in figure 9-22.

MC-9 MAINTENANCE MANUAL

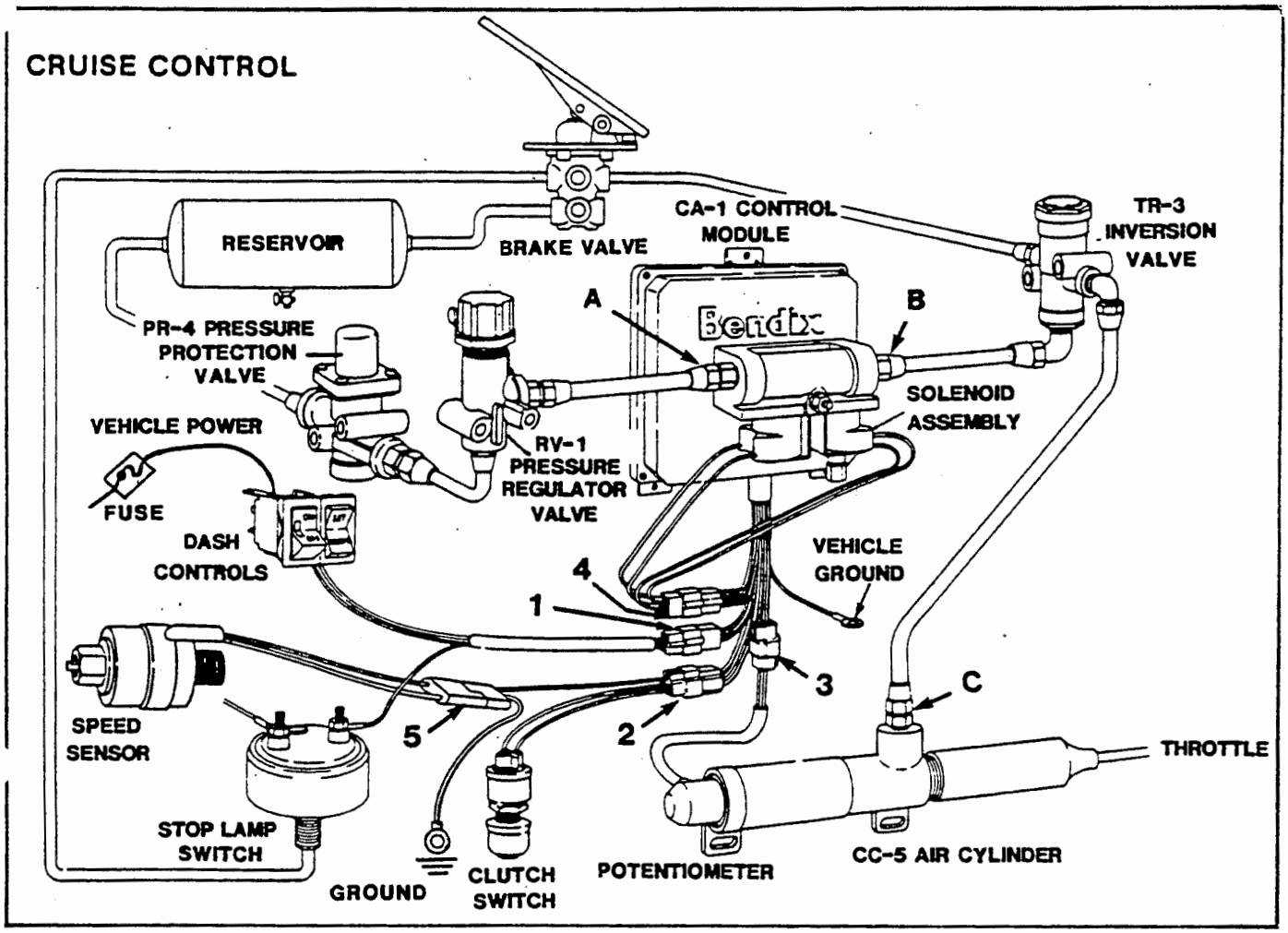


Figure 9-20. Cruise Control System.

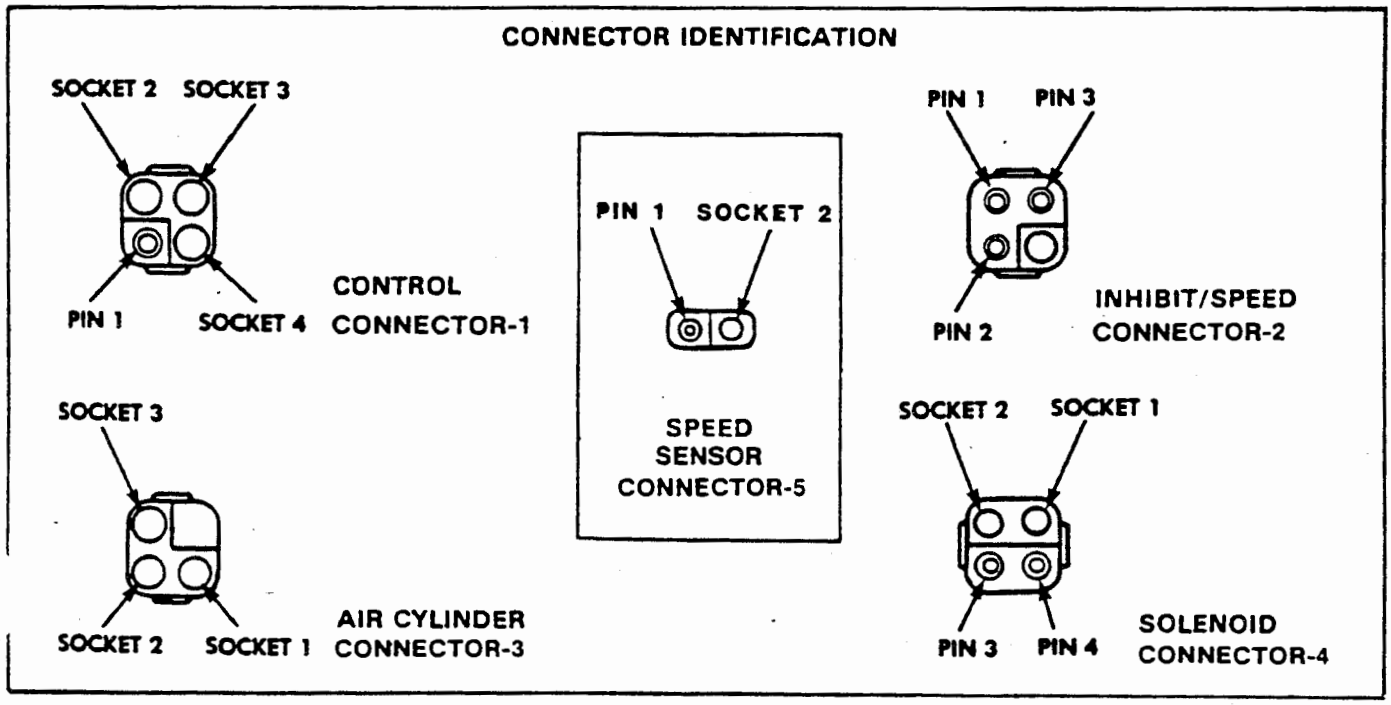


Figure 9-21. Cruise Control Pictorial and Connector Diagrams.

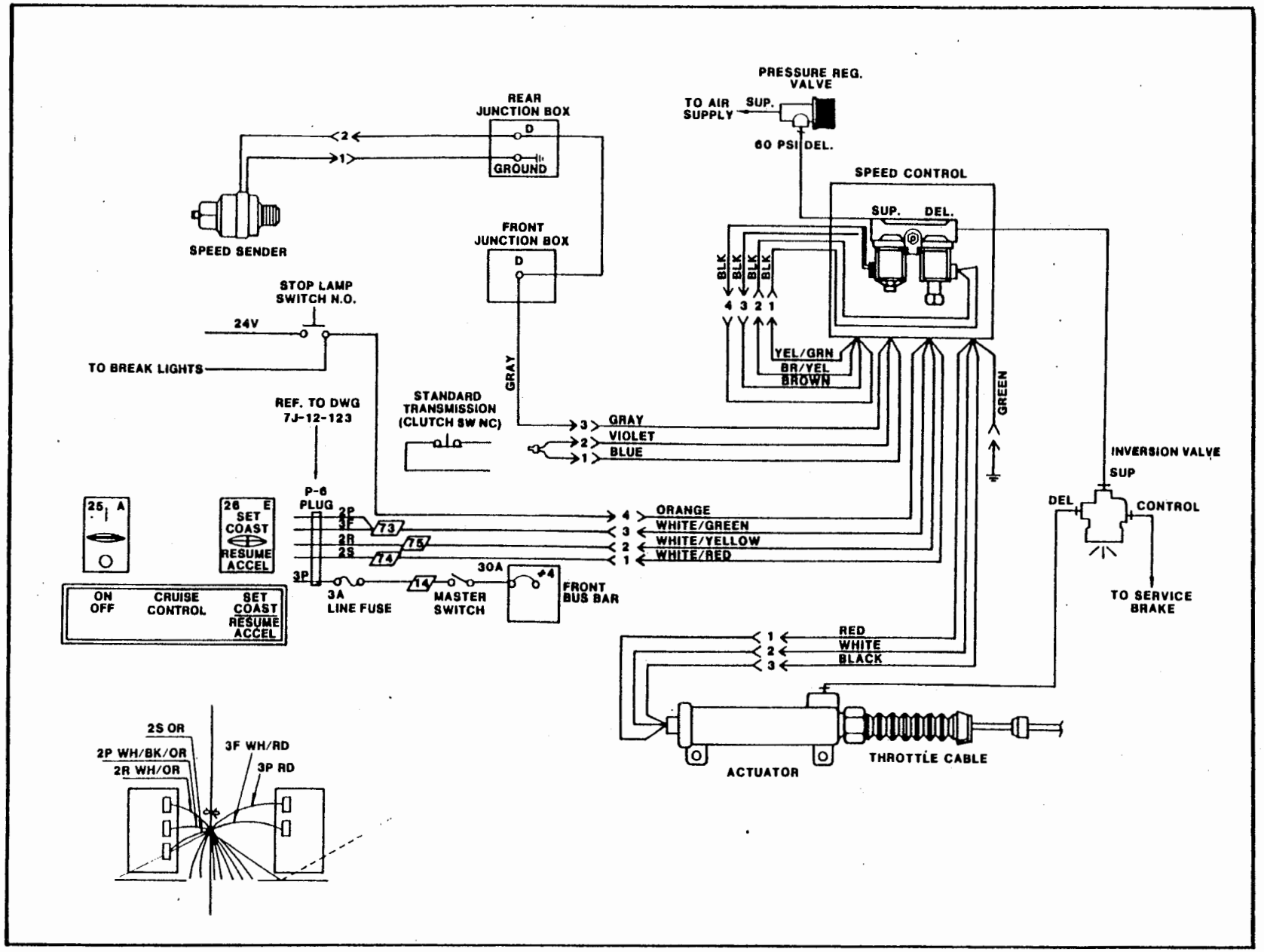


Figure 9-22. Cruise Control Wiring Schematic (Non-DDEC Engine).

MC-9 MAINTENANCE MANUAL

CONNECTOR NO.	TERMINAL SOCKET, OR PIN	CIRCUIT
1	1	Set switch
	2	Resume switch
	3	vehicle electrical power
	4	stop lamp switch
2	1	clutch switch
	2	clutch switch electrical power
	3	speed sensor input
3	1	potentiometer supply
	2	potentiometer wiper
	3	potentiometer ground
4	1	supply solenoid
	2	exhaust solenoid
	3	exhaust solenoid power
	4	supply solenoid power

TROUBLE	CAUSE
SYSTEM IS "SLUGGISH" IN RESPONSE WHEN THE SPEED IS SET OR THE ACCELERATION OR COAST FEATURES ARE USED.	1. Bent, kinked or damaged throttle cable assembly. 2. Obstructed or restricted air flow to air cylinder. Check all air lines for kinks, bends or damage. Inspect the air lines, reducing valve, and solenoid assembly. Clean the inversion valve of excessive grease and dirt. 3. Faulty control module. If the source of the problem was not located in the previous checks, replace the control module.
SYSTEM WILL DISENGAGE WHEN A BRAKE APPLICATION IS MADE, BUT AFTER BRAKE RELEASE, THE SYSTEM WILL ATTEMPT TO RESUME THE SET SPEED.	1. Defective stop lamp switch or wiring. Test switch and wiring as specified under 8 following. 2. Defective control module. Replace the control module if the cause of the trouble was not the stop lamp switch.
COACH WILL NOT ACCELERATE WHEN THE RESUME SWITCH IS DEPRESSED AND HELD; WILL NOT RESUME ORIGINAL SET SPEED AFTER BRAKE APPLICATION.	1. Coach speed was at or above the top speed set limit or below the minimum speed setting. The accelerate feature will not operate below 20 mph (32 kmh) or above the top speed set limit. Test the accelerate function with a coach set speed of at least 22 mph (35 kmh) but less than 55 mph (88 kmh). 2. System was turned off since the last speed setting. If the Master Control switch or the cruise control system was turned off, a speed set must be made before the resume or accelerate function will operate. 3. Faulty Resume switch or wiring. With system turned on, disconnect connector number 1. With Resume switch depressed, check for 24 VDC at socket 2. If power is not detected, check for power at the Resume switch while it is being depressed. If 24 VDC is present, replace the wiring harness; if not, replace the resume switch. 4. Defective control module. If the cause of the trouble was not located in the previous tests, replace the control module.
(Standard transmission coaches) SYSTEM DOES NOT DISENGAGE WHEN CLUTCH PEDAL IS DEPRESSED.	1. Defective stop lamp switch or wiring. Test switch and wiring as specified under 8 following. 2. Faulty control module. If the stop lamp switch was found to be in good condition, replace the control module.

MC-9 MAINTENANCE MANUAL

TROUBLE	CAUSE
CRUISE CONTROL WILL NOT SET	1. Coach speed was below 20 mph or above the preset top limit when Set switch was depressed. 2. Cruise control Power switch not ON. 3. Defective Power switch or wiring to or from Power switch. Check for presence of 24 VDC AT SWITCH TERMINALS AS REQUIRED. Replace switch or wiring if defective. 4. Set/Resume switch defective or grounded, or defective wiring to or from switch. Check for presence of 24 VDC as required at connector 1 when switch is held in SET and RESUME positions. Replace switch or wiring if defective. 5. Defective solenoid assembly, air pressure reducing valve, or wiring. Perform the following tests: a. Build coach air system pressure to governor cutout and secure in place by means other than air brakes. b. Turn off cruise control. c. Disconnect wiring connector 4. d. Apply +24 VDC to socket 1 and -24 VDC to pin 4 while making observation in step 5. e. Listen for audible click and sound of air escaping from exhaust port on exhaust solenoid. If exhaust is heard, proceed to step 7. f. If no clicks are heard, solenoid assembly must be replaced. g. If solenoid clicks and no air is exhausted, check for presence of 60 psi (414 kPa) air pressure at the solenoid. If air pressure check is satisfactory, replace exhaust solenoid. If 60 psi is not present, the reducing valve or connecting air lines must be repaired or replaced. 6. Defective inversion valve or air cylinder. Perform the following tests: a. Apply +24 VDC to pins 3 and 4 and -24 VDC to sockets 1 and 2 of connector 4 while making observation in step 2. b. Listen for audible click and observe movement of throttle cable at air cylinder. c. If throttle does not move, check for air pressure at fittings B and C (solenoid assembly and air cylinder). d. If air pressure is present at B but not at C, inversion valve or connecting air lines must be repaired or replaced. e. If no air pressure is present at B, replace solenoid assembly. f. If air pressure is present at C, check for damage to air cylinder and/or throttle cable. Check for cable binding and repair as required. Check resistance between sockets of connector 3, as shown in following chart: Socket — Resistance 1 and 3 — 3600-4400 ohms 2 and 3 — 1080-1320 ohms 1 and 2 — 4320-5280 ohms If these values are not obtained, replace air cylinder potentiometer or repair potentiometer wiring as required. 7. Defective control module. Perform the following tests: a. Turn cruise control system off. b. Measure resistance between control module ground wire and coach ground. Measure resistance between socket 3 of connector 3 and control module ground wire. In both cases resistance should be 0. Replace control module if any resistance is measured.

MC-9 MAINTENANCE MANUAL

TROUBLE	CAUSE
CRUISE CONTROL WILL NOT SET	8. Defective air brake stop lamp switch or associated lines. Perform the following tests: a. Secure coach from rolling by blocking the wheels. b. Vent all air pressure by opening the drain cocks. c. Turn ignition or master control switch to ON and observe the brake lights. If they are lighted, replace the air brake stop lamp switch. d. If brake lights are not lighted, close the drain cocks and build coach air pressure to 100 psi (690 kPa). With engine operating, apply and release the service brakes. e. Vent all air pressure by opening the drain cocks. f. Check for presence of 24 VDC at both terminals of the brake stop lamp switch. If voltage is present, check for air pressure trapped in stop lamp switch air line. If air pressure is present, determine the cause and repair the air system. If no air pressure is present, replace the stop lamp switch. 9. Defective speed sensor. Perform the following test: a. Check for loose or improper mounting of speed sensor. Correct as required. b. Jack up the coach drive wheels and block the front wheels. Place transmission in neutral and release the air brakes. c. Disconnect connector number 2. Measure the resistance between terminal 3 of the connector and coach ground. If resistance is not between 250 and 3000 ohms, speed sensor or associated wiring is shorted or open. d. Ground pin 3 of connector with a jumper wire. Disconnect connector 5. Measure the resistance between pin 1 and coach ground, and between socket 2 and ground. If the resistance is greater than 10 ohms in either test, replace the wiring between connectors 2 and 5. e. Set ohmmeter on lowest DC voltage scale and connect the leads to pin 1 and socket 2 of the speed sensor side of connector 5. Rotate the coach drive wheels and observe the ohmmeter indication. If the meter needle is not deflected from one side of 0 to the other during wheel rotation, the speed sensor is defective. 10. (Standard Transmission Coach) Clutch pedal travel insufficient, clutch switch misadjusted or defective, or associated wiring faulty. a. Turn cruise control system power on. Check if clutch pedal is fully released and in firm contact with clutch switch. b. With clutch out (released), check for 24 VDC at both terminals of clutch switch. If voltage is present at both terminals, proceed to step 5. c. If voltage is present at only one terminal, depress the switch manually and check for power at both terminals. If there is power at both terminals when the switch is manually depressed, the switch requires adjustment. If not, the switch is defective. d. If there is not 24 VDC at either switch terminal, turn the cruise control system off and measure the resistance across the terminals of the clutch switch. If resistance is more than 2 ohms, the switch is defective. e. Measure the resistance across pins 1 and 2 of connector 2. If the resistance measures more than 5 ohms, the wiring to the clutch switch is defective.

MC-9 MAINTENANCE MANUAL

TROUBLE	CAUSE
SYSTEM DROPS OUT OF CRUISE MODE BY ITSELF, AND SPEED MUST BE RESET	1. Shorted stop lamp switch or wiring. 2. Power to control module intermittent. Inspect wiring and on/off switch and replace as needed. 3. Speed sensor switch defective or improperly adjusted. Switch wiring faulty. 4. Defective CA-1 control module; replace if 1,2 or 3 are not the cause of the trouble.
SYSTEM INTERMITTENTLY DROPS OUT OF CRUISE MODE BUT RESUMES ORIGINAL SPEED OR CLOSE TO IT; DOES NOT REQUIRE MANUAL RESETTING OF THE SYSTEM.	1. Set switch has internal mechanical fault — replace. 2. On standard transmission coach, clutch switch faulty or improperly adjusted. 3. Defective control module; replace if 1 or 2 is not the cause of the trouble.
SYSTEM DROPS OUT OF A SMOOTH CONTROL AND OSCILLATES ABOVE AND BELOW SPEED SETTING. RETURNS BY ITSELF TO SMOOTH CONTROL MODE.	1. Intermittent shorting or breaking of the air cylinder potentiometer wiring. Inspect for faulty wiring; replace potentiometer. 2. Defective control module or wiring. Replace module if source of trouble was not potentiometer.
SYSTEM OSCILLATES ABOVE AND BELOW SPEED SETTING; WILL NOT HOLD SET SPEED WITHIN ±1 MPH ON LEVEL HIGHWAY.	1. Speed sensor defective or improperly adjusted. Test sensor output as described in 9 above. 2. Air cylinder improperly installed. Check the travel of the throttle cable in relation to the full travel of the engine throttle. The air cylinder should increase engine rpm from idle to governed rpm in not less than 1¼" (31 mm). 3. Air cylinder potentiometer or associated wiring defective. Visually inspect for broken or damaged wiring. Disconnect connector number 3 and check the resistance between the sockets and terminals. Resistance values are shown in f,6, above. If these readings are not obtained, replace the air cylinder potentiometer. 4. Faulty control module. If the cause of the trouble was not isolated in the previous tests, replace the control module.

MC-9 MAINTENANCE MANUAL

FUEL SYSTEM SPECIFICATIONS

STANDARD PRIMARY FUEL FILTER (STRAINER)

Manufacturer	AC
Type	Spin-on
Element & Gasket Part No.	25010776 (T-915)
Element Torque	Torque 2/3 of a turn after contacting gasket

STANDARD SECONDARY FUEL FILTER

Manufacturer	AC
Type	Spin-on
Element & Gasket Part No.	25010778 (TP-916)

OPTIONAL PRIMARY FUEL FILTER (STRAINER)

Manufacturer	AC
Type	Cartridge
Element & Gasket Part No.	5575032 (T-552)

OPTIONAL SECONDARY FUEL FILTER

Manufacturer	AC
Type	Cartridge
Element & Gasket Part No.	5574508 (TP-540X)

FUEL TANK

Capacity, Imp.	120 gals. (545 liters)
Capacity, U.S.	144 gals. (545 liters)
Auxiliary Fuel Tank, U.S. (Option)	35 gals. (132.5 liters)

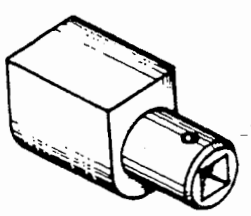
AIR CLEANER — DRY TYPE

Number Used	1
Manufacturer	Nelson
Element No.	9G-3-37(70773-A)

AIR RESTRICTION INDICATOR

Number Used	1
Manufacturer	Filter Minder
Indicates	at 25" (635 mm) water

SERVICE TOOLS



MANY OF THE TOOLS LISTED IN THIS SECTION ARE SPECIALLY DESIGNED TO MEET THE NEEDS OF VARIOUS SERVICE OPERATIONS. THEY ARE AVAILABLE FOR PURCHASE THROUGH MOTOR COACH INDUSTRIES, SERVICE PARTS DIVISION AND UNIVERSAL COACH PARTS OR WHERE PRACTICAL, MAY BE MANUFACTURED BY THE OPERATOR. IN THESE CASES, DRAWINGS ARE AVAILABLE UPON REQUEST.

20-33 Socket - Tightening Fuel Line Fittings

Date 1-1-89

MC-9 MAINTENANCE MANUAL

SECTION 10
LUBRICATION

SUBJECT	PAGE
Grease Fitting Plate	10-2
Lubrication Locations	10-5
Lubricant Requirements Chart	10-6
Lubrication Schedule	10-3
Oil Changes	10-1
Preventive Maintenance Schedule	10-7
Service Bulletin Page	

MC-9 MAINTENANCE MANUAL

LUBRICATION

Engine crankcase oil should be checked daily or before the start of each run and oil added to bring the level to the "Full" mark on the dipstick. A new oil filter element should be installed each time the crankcase oil is changed.

OIL CHANGES

The oil service period is dependent on the operating conditions (e.g. load factors, etc.) of an engine that will vary with the numerous service applications. The oil change interval should be based on 300 operating hours times the average vehicle operating speed. See the example in the chart, below.

AVG. OPERATING SPEED	OIL CHANGE INTERVAL	
	Miles	Km
50 mph (x 300 hrs =)	15,000	24,000
40 mph	12,000	19,000
30 mph	9,000	14,500

The oil change interval may be gradually increased or decreased with experience on a specific lubricant while also considering the recommendations of the oil supplier (analysis of drained oil can be helpful) until the most practical oil change period for the particular service has been established.

Solvents should not be used as flushing oils in running engines. Dilution of the fresh refill oil supply can occur, which may be detrimental.

Full flow oil filtration systems have been used in 6V-92 and 8V-92 diesel engines since they were first introduced. For the best results, the oil filter element should be replaced each time the oil is changed.

Engine flow oil temperature should be checked every 25,000 miles (40,000 km) to determine oil cooler efficiency. This check should be made by inserting a steel jacketed thermometer in the dipstick opening immediately after stopping a hot, loaded engine. If the oil temperature exceeds the coolant temperature by more than 60°F (33°C), the oil cooler may be clogged.

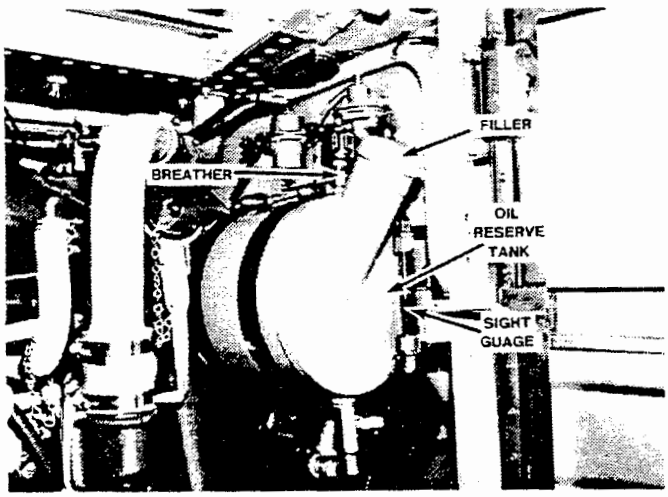


Figure 10-1. Engine Lubrication Tank (Optional) and Related Components.

Satisfactory prolonged heavy-duty engine operation requires heavy-duty lubricating oils with additives. These oils provide better lubrication, have more heat resistance and counteract sludge formation more effectively than the straight mineral type oils. Refer to Section 8, Engine, for detailed oil specifications.

OIL RESERVE TANK

A two-gallon (7.6 L) oil reserve tank is available as optional equipment (see figure 10-1). It is connected to the crankcase by a hose with a shut-off valve, allowing oil to be added to crankcase by opening the valve. Comparison of oil levels in the sight gauge, before and after adding oil to the crankcase, shows how much oil was added.

COLD WEATHER OPERATION

Cold weather starting will be easier when immersion type electrical coolant heaters are used. Other practical consideration, such as the use of batteries, cables and connectors of adequate size, proper setting of voltage regulators, ether starting aids, and proper fuel selection will enhance starting with the use of SAE30 or SAE40 oils.

BREAK IN PERIOD

Lubricant in the transmission and differential supplied as "factory fill" in new coaches should be drained and refilled after 1,000 miles (1,600 km) and in no case over 3,000 miles (4,800 km) of initial operation.

A lubrication chart is included in this section to give approximate location of key service points on the 96A2/102A2 and 96A3/102A3 model coaches. Where cleaning, removal or disassembly are required for lubrication purposes, these procedures are covered in the applicable sections of this manual.

Lubricant compartments of the engine and transmission are provided with dipsticks for checking lubricant level. Power steering fluid reservoir and blower drive gear box are equipped with sight gauges to facilitate checking of oil level.

A preventive maintenance schedule is also included at the end of this section. It includes lubrication, cleaning and inspection intervals.

FLEXIBLE HOSES

MAINTENANCE

The performance of the engine and auxiliary equipment is greatly dependent on the ability of flexible hoses to transfer lubricating oil, air, coolant, and fuel oil. Maintenance of hoses is an important step to ensure efficient, economical and safe operation of the engine and related equipment.

Check hoses daily as part of the pre-start up inspection. Examine hoses for leaks, and check all fittings, clamps, and ties carefully. Ensure that hoses are not resting on or touching shafts, couplings, heated surfaces including exhaust manifolds, any sharp edges, or other obviously hazardous areas. Since all machinery vibrates and moves to a certain extent, clamps and ties can loosen and wear with age. To ensure continued proper support, inspect fasteners frequently and tighten or replace them as necessary.

MC-9 MAINTENANCE MANUAL

Investigate leaks immediately to determine if fittings have loosened or cracked and also if hoses have ruptured or worn through. Take corrective action immediately. Leaks are not only potentially detrimental to machine operation, but can also result in added expense caused by the need to replace lost fluids.

WARNING: Personal injury and/or property damage may result from fire due to the leakage of flammable fluids such as fuel or lube oil.

SERVICE LIFE

A hose has a limited service life, determined by the temperature and pressure of the gas or fluid within it, time in service, mounting, ambient temperatures, amount of flexing, and the vibration it is subject to. With this in mind, TMC/MCI recommends that all hoses be thoroughly inspected at least every 500 operating hours and/or annually. Look for cover damage or indications of damaged, twisted, worn, crimped, brittle, cracked, or leaking lines. Hoses having the outer cover worn through or damaged metal reinforcement should be considered unfit for service.

TMC/MCI further recommends that all hoses be replaced during major overhaul and/or after a maximum of five years service. Replacement hose assemblies should always be equal or superior to the original equipment supplied with the engine.

Review the plumbing and fasten hoses only after the engine or related machinery are installed. Make sure that hoses are routed and clipped properly to prevent damage from vibration, abrasion, heat, and mechanical loads. Extra fasteners or readjustment of an existing support may be required during the operating life of a unit.

Hoses routed close to heated surfaces may have a shortened service life. Additional shields or protective sleeves may extend hose life in special applications where shortened life is anticipated or has been experienced. Consult with the hose manufacturer relative to alternate hose compositions where shields and sleeves are impractical.

The service life of a hose may also be reduced by exposure to road salt. Some types of hoses with wire braid reinforcement are subject to oxidation damage and a subsequent reduction in hose strength.

The proper installation, routing and fitting torque criteria for hoses can be obtained from major hose suppliers and manufacturers.

GREASE FITTING PLATE

A grease fitting mounting plate is attached to a master bracket in the left front service compartment to the rear of the pitman arm. These zerk fittings are connected to lubricating lines which lead to points listed on the nameplate. See figure 10-2.

The nameplate explains the function of each fitting.

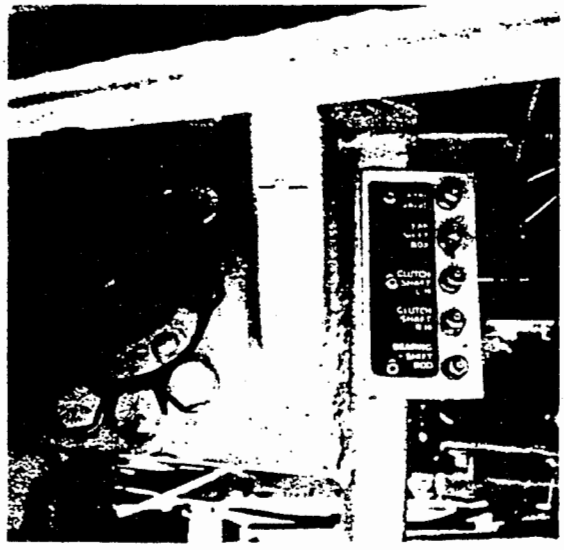


Figure 10-2. Grease Fitting Mounting Plate.

MC-9 MAINTENANCE MANUAL

LUBRICATION SCHEDULE (Refer to figure 10-3 for locations.)

SERVICE INTERVAL A — Check Daily - Service as Required.

ITEM NUMBER*	DESCRIPTION	LUBE METHOD	LUBRICANT**
1	Engine Crankcase	Fill	0-1 (SAE 30 or 40)
2	Blower Gearbox	Fill	0-1 (SAE 30)
3	Power Steering Reservoir	Fill	0-1 (SAE 10-W-40)
4	Front and Trailing Axle Wheel Bearings	Fill	0-1 (SAE 30)
5	Transmission (automatic)	Fill	0-5
	Transmission (standard)	Fill	0-1 (SAE 30 below 10°F/-18°C) (SAE 40 or 50 above 10°F/-18°C)

SERVICE INTERVAL B — Every 150 hrs or 5,000 miles (8,000 km).

6 & 7	Tie rod ends and lower drag link ends	Zerks (all points)	L-5
8	Brake Camshaft - front wheels	Zerks (each side)	L-5
9	Front Slack Adjusters	Zerks (each side)	L-5
10	King Pin Bushings, upper and lower	2 Zerks (each side)	L-5
11	Propeller Shaft	3 Zerks	L-5
12	Brake Camshafts - rear	Zerk (each side)	L-5
13	Rear Slack Adjusters	Zerk (each side)	L-5
14	Rear Brake Chambers	Apply	L-6
15	Differential	Fill/Change	G-1 (Below 0°F/-18°C) G-2 (Above 0°F/-18°C)
16	Air Cleaner (Dry Type)	Check and Replace Element As Required	
38	Clutch Linkage	Zerk	L-5
39	Trailing Axle Pivot	Zerk	L-5

Steering Gear Compartment

19	Steering Drag Link End	Zerk	L-5
20	Steering Shaft U-joint	2 Zerks	L-5
21	Steering Shaft Slip Joint	Zerk	L-5
40	Fitting on Front Central Lube Plate	3 Zerks	L-5
41	Clutch Lever Bearing	Zerk	L-5

Engine Compartment

22A	A/C Compressor Mounting Pivot	Zerk	L-5
22B	Shutter Rods & Cranks	Apply	O-2
43	Clutch Release Bearing	Zerk	A-2

*** See Location Diagram, figure 10-3.**
**** See Lubricant Requirements Chart.**

MC-9 MAINTENANCE MANUAL

SERVICE INTERVAL C — Every 300 hrs or 10,000 miles (16,000 km).

ITEM NUMBER*	DESCRIPTION	LUBE METHOD	LUBRICANT**
23	Engine Crankcase	Drain, Fill	0-1 (SAE 30 or 40)
24	Engine Oil Filter	Change	
25	Shutterstat Air Filter	Add	F-2
	Service Door Hinges	Apply	L-3
44	Fuel Filters	Change	
26	Entrance Door Linkage (remove panel for access behind target panel) & Door Air Lock Mechanism	Apply	0-2
45	Entrance Door Hinges	Apply	L-3

SERVICE INTERVAL D — Every 750 hrs or 25,000 miles (40,000 km).

27	Brake Anchor Pins (Caution: Do not overlubricate.)	4 Zerks (2 ea. side)	L-5
15	Differential	Drain,Fill	G-1 (Below 0°F/-18°C) G-S (Above 0°F/-18°C)

SERVICE INTERVAL E — Every 1,500 hrs or 50,000 miles (80,000 km).

	Air Cylinders - various locations	Remove air lines and apply	0-1 (SAE 30)
29	A/C Compressor Air Cylinder	Apply	0-1 (SAE 30)
30	Blower Air Cylinder	Apply	0-1 (SAE 30)
31	Steering Column	2 Zerks	L-5
32	Baggage Door and Side Service Door Locks	Apply	0-2
33	Transmission Oil Filter	Replace Element	
34	Condenser Door and Check Strap	Apply	0-2
35	Fuel Tank Door	Apply	0-2
36	Battery Door and Catch	Apply	0-2
42	Transmission (standard)	Drain, Flush, Refill	0-1 (SAE 30 Below 10°F/-12°C) 0-1 (SAE 40 or 50 Above 10°F/-12°C)

SERVICE INTERVAL F — Every 2250 hrs or 75,000 miles (121,000 km).

3	Power Steering Reservoir Filter	Replace Element	0-1 (SAE 10-W-40)
37	Power Steering Line Filter	Replace Element	0-1 (SAE 10-W-40)
	Air Suspension Filter	Replace Element	

SERVICE INTERVAL G — Every 3,000 hrs or 100,000 miles (161,000 km); at each brake rebuild.

4	Wheel Bearings and Seals	Inspect, Apply	0-1 (SAE 30)

* See Location Diagram, figure 10-3.
** See Lubricant Requirements Chart.

MC-9 MAINTENANCE MANUAL

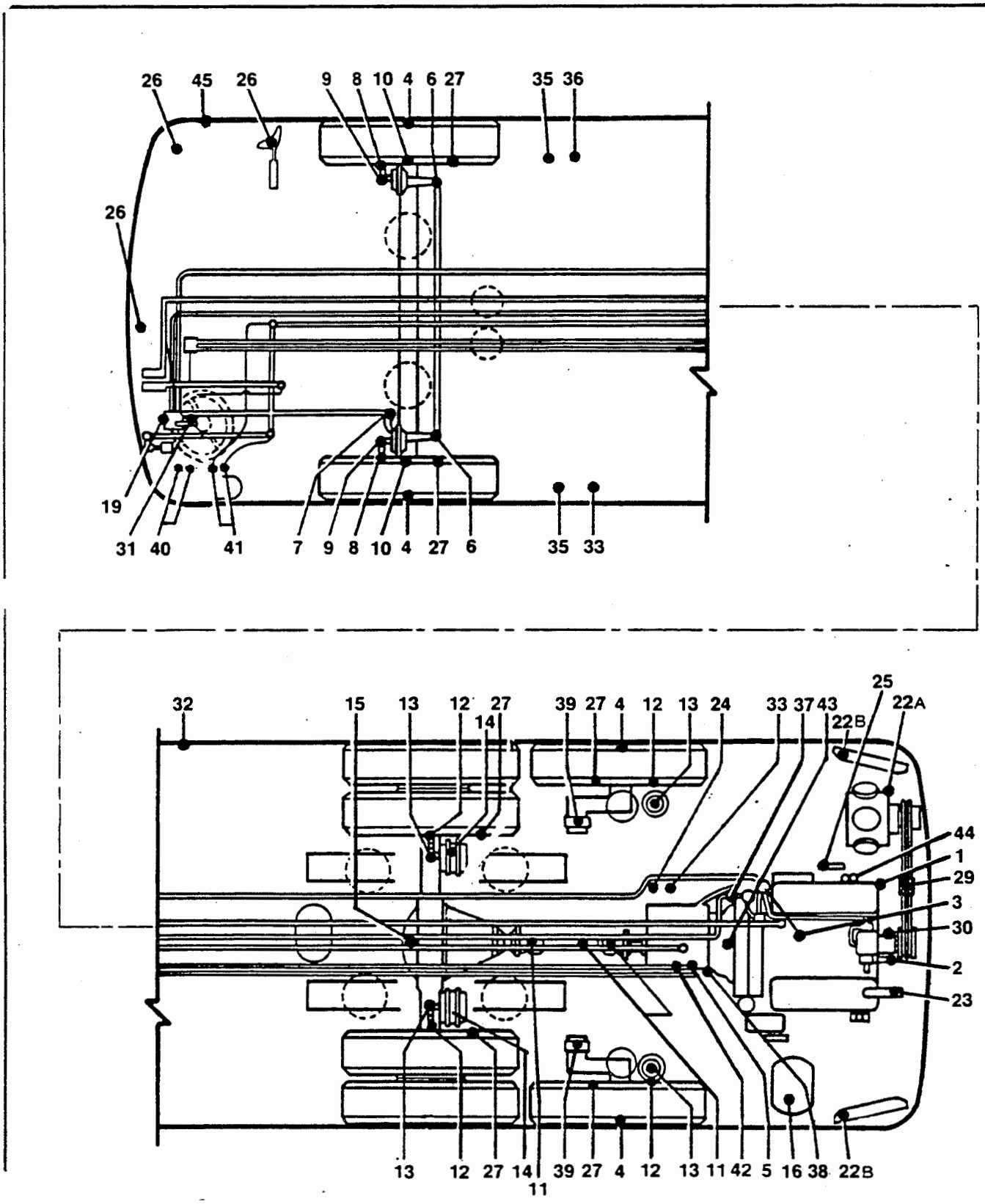


Figure 10-3. Lubrication Item Numbers and Locations.

MC-9 MAINTENANCE MANUAL

ROUTINE SERVICE

LUBRICATION CODE

0-1	H.D. Engine Oil MIL-L-2104C or MIL-L-46152
0-2	Rust Preventative Oil
0-5	Dexron II® Automatic Transmission Oil
L-2	High Melting Point Water Resistant Lithium-Base Grease
L-3	"Lubriplate" No. 105
L-5	Molybdenum Disulphide Grease
L-6	Molykote #DC-55M
G-1	General Purpose Gear Lubricant -SAE 90 (A.P.I. Spec. GL5)
G-2	General Purpose Gear Lubricant -SAE 140 (A.P.I. Spec. GL5)
F-1	Silicone Fluid - 750 Centistokes Viscosity
F-2	Special "Kysor" Air Filter Fluid
A-1	10W40 Engine Oil - The Only Approved products are:

Marketer	**Trade Name**
Mobil Oil Corporation	Mobil Super
Texaco Refinery Corporation	Texaco Havoline Supreme
Valvoline Oil Company	Valvoline DII Climate
	Valvoline XLD
	Ashland 300M
	Ashland 4S
Union Oil Company	Union Super

A-2 High Temperature Grease such as the following:

American Oil Co.	Amoco Lithium - M.P. Grease
City Service Co.	Citgo Premium Lithium Grease No. 2
Keystone Lubricating Co.	No. 81 Light
Mobile Oil.	Mobilgrease M.P.
Shell Oil Co.	Retinax A
Atlantic Richfield Co.	Arco M.P.
Texaco	Multifak No. 2
Humble Oil Co.	Lidok 2
Shell Oil Co.	Alvania No. 2
Chevron Oil Co.	Teknifax BRB-2, S.R.I.

MC-9 MAINTENANCE MANUAL

Preventive Maintenance (PM) Schedule

The following preventive maintenance schedule is a compilation of suggested maintenance operations contained in this maintenance manual.

Service intervals may be given as regular intervals (Reg. Int.) months and/or miles. Regular intervals must be determined by shop personnel based on operating conditions, component failure history and previous experience. In cases when both time (in months) and miles (in thousands) are given for a particular operation, maintenance should be performed at whichever interval first occurs.

MAINTENANCE OPERATION	Lube Key	Months	Reg. Int.	SERVICE INTERVAL (Miles) 5,000	10,000	12,000	15,000	18,000	20,000	25,000	30,000	50,000	100,000	200,000	250,000			
1 - FRONT AXLE																		
FRONT AXLE INSPECTION			●															
CHECK FRONT AXLE WHEEL ALIGNMENT			●															
2 - REAR AXLE																		
CHECK OIL LEVEL - (DIFFERENTIAL)			●															
DRAIN & FILL - (DIFFERENTIAL)										●								
INSPECT REAR AXLE			●															
3 - BODY																		
INSPECT WINDSHIELD WIPERS			●															
INSPECT & ADJUST ALL DOORS & LINKAGE		3																
INSPECT & LUBE DRIVER'S SEAT		6																
INSPECT WALL & ROOF SEAMS			●															
LUBRICATE SERVICE DOOR HINGES					●													
LUBRICATE ENTRANCE DOOR HINGES			●															
CHECK & LUBRICATE BAGGAGE DOOR LOCKS				●														
4 - BRAKES & AIR SYSTEM																		
INSPECT ALL AIR LINES & FITTINGS				●														
INSPECT AIR RESERVOIR			●															
TEST LOW PRESSURE INDICATOR		6																
CLEAN & INSPECT SINGLE CHECK VALVES		6																
TEST PRESSURE PROTECTION VALVE OPERATION		3									●							
INSPECT FRONT BRAKE HARDWARE			●															
INSPECT & TEST FRONT BRAKE CHAMBERS			●															
REPAIR & TEST FRONT BRAKE CHAMBERS		12											●					
CLEAN & INSPECT QUICK RELEASE VALVES		12																
LUBRICATE BRAKE CAMSHAFTS				●														
LUBRICATE SLACK ADJUSTERS				●														
LUBRICATE BRAKE SHOE ANCHOR PINS										●								
INSPECT SLACK ADJUSTERS			●															

MC-9 MAINTENANCE MANUAL

MAINTENANCE OPERATION	Lube Key	Months	Reg. Int.	SERVICE INTERVAL (Miles) 5,000	10,000	12,000	15,000	18,000	20,000	25,000	30,000	50,000	100,000	200,000	250,000
4 - BRAKES & AIR (CONT'D)															
LUBRICATE BRAKE & ACCELERATOR TREADLES				●											
CLEAN & INSPECT BRAKE TREADLE VALVE				●											
INSPECT AIR INTAKE SYSTEM			●												
INSPECT AIR COMPRESSOR		6										●			
INSPECT & CLEAN AIR COMPRESSOR		24												●	
CLEAN COMPRESSOR GOVERNOR FILTERS							●								
CLEAN & INSPECT COMPRESSOR GOVERNOR													●		
CLEAN & INSPECT AUTOMATIC DRAIN VALVE			●												
INSPECT AIR DRYER		3	●												
REPLACE DRYER DESICCANT		12													
INSPECT PARKING BRAKE RELAY VALVE		1			●										
CLEAN & INSPECT PARKING BRAKE RELAY VALVE		12										●			
CLEAN & INSPECT REAR SERVICE PARKING BRAKE		12										●			
INSPECT REAR BRAKE HARDWARE				●											
LUBRICATE BRAKE SHOE ANCHOR PINS										●					
LUBRICATE BRAKE CAMSHAFTS				●											
LUBRICATE SLACK ADJUSTERS				●											
CLEAN & INSPECT DOUBLE CHECK VALVES												●			
INSPECT & TEST PRESSURE REDUCING VALVE											●				
CLEAN & TEST PRESSURE REDUCING VALVE												●			
LUBRICATE SHUTTERSTAT AIR FILTER					●										
AIR CYLINDERS - REMOVE AIR LINES & OIL												●			
CLEAN & INSPECT PARKING BRAKE CONTROL VALVE		12											●		
5 - CLUTCH															
INSPECT & LUBE CLUTCH LINKAGE				●											
LUBE CLUTCH LEVER GEARING				●											
LUBE CLUTCH RELEASE BEARING				●											
6 - COOLING SYSTEM															
INSPECT COOLING SYSTEM			●												
LUBRICATE SHUTTER RODS & CRANKS				●											
LUBRICATE BLOWER AIR CYLINDER												●			
CHECK COOLANT LEVEL			●												
CHECK WATER FILTER						●									
CHECK BLOWER GEAR BOX			●												
7 - ELECTRICAL SYSTEM															
TEST ALTERNATOR OUTPUT				●											
INSPECT VOLTAGE REGULATOR			●												
INSPECT STARTER			●												

MC-9 MAINTENANCE MANUAL

MAINTENANCE OPERATION	Lube Key	Months	Reg. Int.	SERVICE INTERVAL (Miles) 5,000	10,000	12,000	15,000	18,000	20,000	25,000	30,000	50,000	100,000	200,000	250,000			
8 - ENGINE																		
INSPECT ENGINE THERMOSTAT		12							●									
INSPECT INJECTORS & VALVE LASH		30										●						
REPLACE ENGINE LUBE OIL					●					●								
CHECK ENGINE LUBE OIL LEVEL			●															
REPLACE ENGINE LUBE OIL FILTERS					●													
INSPECT TURBOCHARGER			●															
INSPECT EXHAUST SYSTEM			●															
9 - FUEL SYSTEM																		
INSPECT FUEL SYSTEM				●														
REPLACE FUEL FILTERS		6			●													
INSPECT THROTTLE DELAY		30										●						
11 - STEERING																		
LUBRICATE DRAG LINK ENDS				●														
LUBRICATE STEERING TIE ROD ENDS				●														
LUBRICATE STEERING SHAFT SLIP JOINT				●														
LUBRICATE STEERING SHAFT U-JOINT				●														
CHECK POWER STEERING RESERVOIR			●															
STEERING COLUMN LUBE												●						
REPLACE POWER STEERING RESERVOIR FILTER												●						
REPLACE POWER STEERING LINE FILTER												●						
INSPECT STEERING TORQUES								●		●		●						
12 - SUSPENSION																		
CHECK FRONT RIDE HEIGHT			●															
CHECK TIRE INFLATION			●															
INSPECT SUSPENSION TORQUES								●		●		●						
INSPECT REAR SUSPENSION			●															
CHECK REAR RIDE HEIGHT			●															
LUBRICATE TRAILING AXLE PIVOT				●														
13 - TRANSMISSION																		
INSPECT TRANSMISSION			●															
CHECK FLUID LEVEL			●															
REPLACE TRANSMISSION OIL												●						
SERVICE TRANSMISSION INTERNAL OIL FILTER															●			
REPLACE TRANSMISSION EXTERNAL OIL FILTER												●						
14 - PROPELLER SHAFT																		
LUBRICATE PROP SHAFT U-JOINTS				●														
LUBRICATE PROP SHAFT SLIP JOINT				●														

MC-9 MAINTENANCE MANUAL

MAINTENANCE OPERATION	Lube Key	Months	Reg. Int.	SERVICE INTERVAL (Miles) 5,000	10,000	12,000	15,000	18,000	20,000	25,000	30,000	50,000	100,000	200,000	250,000
15 - WHEELS, HUBS & TIRES															
INSPECT & ADJUST FRONT HUBS & BEARINGS								●							
INSPECT & SERVICE REAR HUBS & BEARINGS							●								
LUBE WHEEL BEARINGS													●		
16 - HEATING & A/C															
AIR FILTER INSPECTION			●												
BLOWER DUCT INSPECTION				●											
CONDENSER FAN & MOTOR INSPECTION				●											
BELT INSPECTION (DAILY INSPECTION RECOMMENDED)			●												
INSPECT A/C COMPRESSOR				●											
INSPECT SUCTION & DISCHARGE LINES				●											
INSPECT COILS				●											
INSPECT EVAPORATOR ENCLOSURE				●											

Date 1-1-89

MC-9 MAINTENANCE MANUAL

SECTION 11
STEERING SYSTEM

SUBJECT	PAGE
Assembly of Steering Gear	11-18
Bleeding Air From Power Steering System	11-28
Disassembly of Steering Gear	11-10
Drag Link	11-32
HFB-70 Integral Steering Gear	11-6
Inspection	11-17
Inspection of Connection Between Pitman Arm & Drag Link	11-33
Installation of Steering Gear	11-28
Power Steering Pressure Filter	11-31
Power Steering Pump	11-29
Power Steering Reservoir and Filter	11-31
Steering Column	11-3
System Maintenance	11-3
System Operation	11-1
Torques at Steering System Connections	11-38
Troubleshooting	11-34
Specifications	11-37
Service Bulletin Page	

MC-9 MAINTENANCE MANUAL

STEERING SYSTEM

The power steering system consists of the following components:

A. Vane-type Hydraulic Pump, Reservoir, Filter and Interconnecting Lines and Hoses
B. Steering Wheel and Column
C. HFB 70 Steering Gear
D. Steering Linkage consisting of a Pitman arm, drag link, steering arm and tie rod.

Steering action is transferred from the steering wheel and column directly to the HFB 70 steering gear. The Pitman arm on the steering gear moves the drag link to the axle steering arm in the proper direction. See figure 11-1.

Steering system and tire wear are affected by air suspension, brakes, wheel bearings, front suspension and front end alignment. These items are covered in their respective sections of this manual. Steering system specifications are given at the end of this section.

SYSTEM OPERATION

Power steering is accomplished by hydraulic pressure. Steering fluid is supplied by a vane-type hydraulic pump, mounted at the left rear of the engine. Hydraulic fluid lines (figure 11-2) are mounted from the power steering reservoir to the pump. Fluid displaced by the pump circulates through flexible lines to the power steering gear. A return line is connected from the steering gear back to the reservoir.

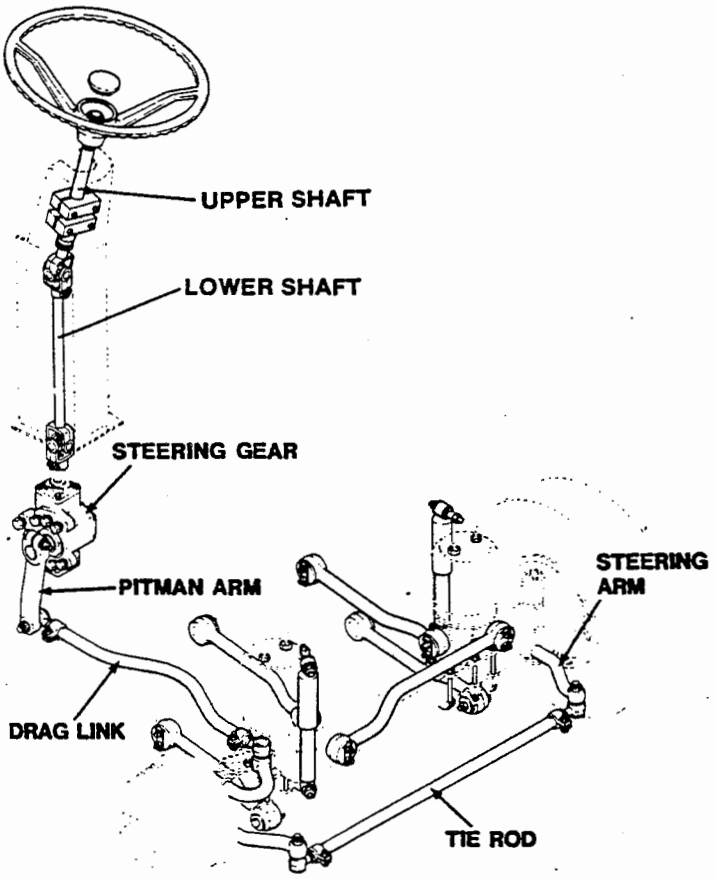
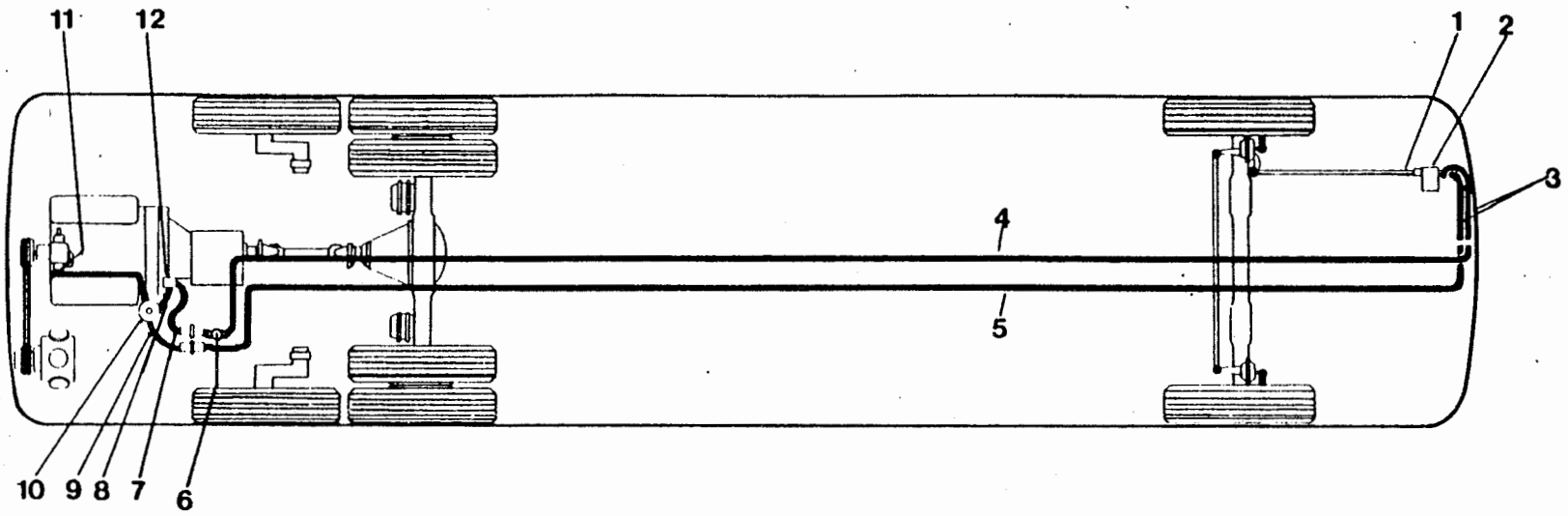


Figure 11-1 . Power Steering System.



1. Drag link
2. Steering gear
3. Hoses - from valve to feed & return lines
4. Feed line tube
5. Return line tube
6. Power steering pressure filter
7. Pump outlet to quick disconnect
8. Hose - from reservoir to pump
9. Hose - reservoir return from quick disconnect
10. Reservoir & filter
11. Power steering fluid fill
12. Power steering pump 1500 p.s.i.

INTEGRAL STEERING LINES & FITTINGS MODEL MC-9

Figure 11-2. Steering Lines and Component Locations.

When the steering wheel is turned, the steering shaft turns the power steering gear actuating shaft. This motion, combined with hydraulic pressure supplied to the gear by the pump, provides the rotating action of the gear output shaft, which is connected to the Pitman arm.

The power steering hydraulic system has two filters to ensure that foreign matter does not enter the pump or the steering gear. A filter in the reservoir filters the steering fluid before it enters the pump and a supply line filter is used to filter the fluid before it enters the steering gear.

SYSTEM MAINTENANCE

The power steering system requires little maintenance. However, the system should be kept clean to ensure maximum operating performance and trouble free service. Periodic inspection should also be made to check for leaks.

At regular intervals, fluid level in the pump reservoir should be checked and fluid added when required. Refer to Power Steering Reservoir and Filter later in this section.

The fluid reservoir and filter assembly is mounted in the upper right corner of the engine compartment. When the slightest evidence of dirt, sludge or water is discovered in the system, disconnect fluid lines at the power steering gear. Drain, and refill the system with clean, recommended fluid. The power steering fluid reservoir filter should be serviced at regular lubrication intervals.

The power steering fluid line filter is in-line mounted. At regular lubrication intervals, the fluid filter element should be removed and replaced. Refer to Power Steering Filter later in this section for service instructions.

Air in the fluid system will cause spongy action and noisy operation. When any hose has been disconnected or when fluid has been lost for any reason, the system must be bled. Bleed the system as described under Bleeding Air From Power Steering System later in this section.

CAUTION: Do not operate the pump without fluid in the pump reservoir.

If the linkage between the steering gear and the front wheels is out of adjustment, bent, twisted or worn, the steering action of the coach will be seriously affected. Whenever any steering linkage parts are repaired, replaced or adjusted, steering geometry and front wheel alignment must be checked and necessary corrections made. Refer to Front Axle for front end alignment information (Section 1).

At regular lubrication intervals, the steering linkage should be thoroughly inspected for worn or loose components; Section 10, Lubrication.

After the coach has been operated continually, and high mileage figures have been reached, overhaul of the various steering units will be required.

General overhaul procedure normally requires removal and disassembly of the entire assembly, cleaning and inspection of all parts and final assembly. Careful inspection of all parts during overhaul is very important and must not be neglected.

REMOVAL OF STEERING COLUMN

1. Shut off the battery switch.

2. Remove steering wheel (refer to Removal of Steering Wheel). Replace the wheel nut on the shaft to avoid losing steering column components.

3. Disconnect the wire from the contact brush terminal located under the turn signal assembly on the left-hand side of the steering column.

4. Loosen the two allen head screws securing the turn signal assembly and remove it from the steering column.

5. Remove the four screws at both the lfloor and dashboard ends of the fiberglass cover.

6. Remove the six screws and the aluminum plate from the middle of the cover and remove the cover from the steering column.

7. Loosen the clamp connecting the steering column to the input shaft of the steering gear.

8. Remove the four bolts and the U-clamps that secure the steering column to the dashboard.

The steering column may now be lifted out of the coach as a complete unit.

INTEGRAL STEERING

DISASSEMBLY OF STEERING COLUMN

1. Remove the steering wheel nut (12).
2. Remove the spring (5), upper spacer (7), washer (8) and nylon bushing (9) from the top of the jacket tube (13).
3. Remove the contact brush (24) from the jacket tube. Slip the upper bearing (14) and jacket tube (13) off the upper wheel shaft. Ensure that the lower bearing remains on the wheel shaft.

MC-9 MAINTENANCE MANUAL

1. Upper Shaft
2. Spacer Collar
3. Washer
4. Cup Washer
5. Spring
6. Lower Spacer
7. Upper Spacer
8. Spring Retainer Washer (2)
9. Nylon Bushing (2)
10. Contact Ring
11. Cable
12. Wheel Nut
13. Jacket Tube
14. Bearing (2)
15. Universal Joint Assembly
16. Universal Joint
17. Flexible Coupling
18. Lower Wheel Shaft
19. Button (2)
20. Pin
21. Bolt (2)
22. Lockwasher (2)
23. Rubber Seal
24. Clamp
25. Capscrew
26. Lockwasher
27. Nut
28. Nut
29. Lockwasher
30. Bolt
31. Screw (2)
32. Contact Brush
33. Fiberglass Cover
34. Lower Cover
35. Seal
36. Seal
37. Seal
38. U-Clamp (4)

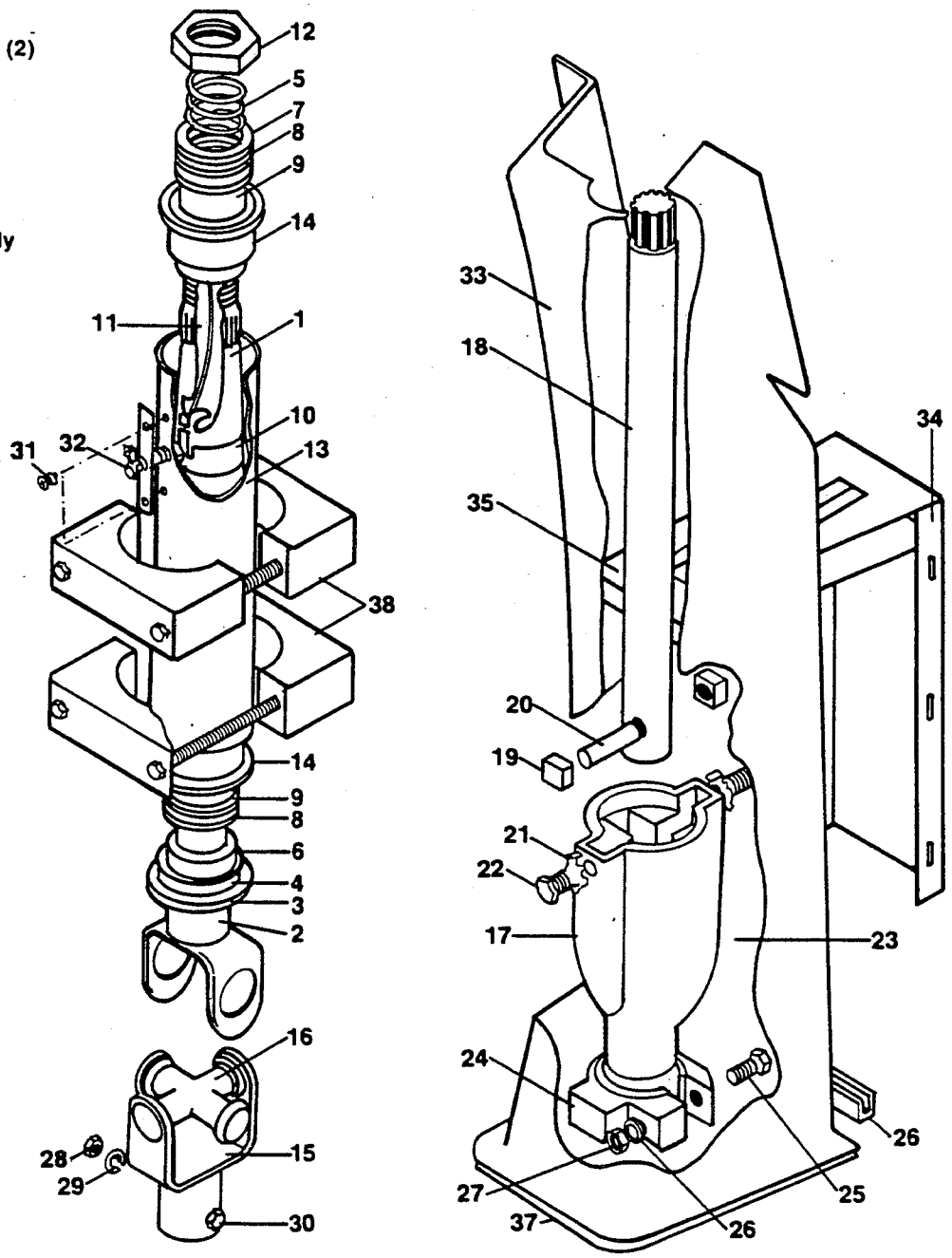


Figure 11-3. Steering Column Disassembled.

4. Unravel the tape on the contact ring (10). Disconnect the cable (11) from the contact ring and remove it from the wheel shaft.

5. Remove the nylon screw that secures the contact ring to the upper wheel shaft and remove the contact ring.

6. Remove the lower bearing (14), nylon bushing (9), washer (8), lower spacer (6), cup washer (4), flat washer (3), and spacer collar (2) from the wheel shaft.

7. Separate the upper wheel shaft (1) from the lower wheel shaft (18) by removing the nut (28), bolt (30), and lock washer (28) from the lower yoke of the universal joint (15).

8. Remove the two bolts (22) and lock washers (21) from the flexible coupling (17). The lower wheel shaft (18) may now be separated from the coupling, and the two buttons (19) and the pin (20) may be removed from the shaft.

This completes disassembly.

DISASSEMBLY OF BEARINGS

To disassemble the bearing remove the snap ring, retaining washer, and felt washer. Separate the bearing halves and remove the rolls.

CAUTION: The bearing contains 20 rolls. If any of the rolls are lost or damaged, the entire bearing must be replaced.

INSPECTION

Inspect the shaft splines, bearings, universal joint and all threads for unusual signs of wear or damage. Replace all parts not in good condition.

REASSEMBLY

Pack the bearings with clean grease and apply grease to the upper wheel shaft for the nylon bushings. Saturate the felt washers with No. 50 oil. Pack the bottom of the flexible coupling with 1 oz. (30 g) of heavy grease.

1. Insert the pin (20) into the hole on the lower wheel shaft (18) and attach one button (19) to either end of the pin.

2. Insert the shaft into the flexible coupling (17) and install lock washers (21) and bolts (22) onto the coupling. If new lock washers are used bend the large tang over the edge of the flexible coupling.

3. Assemble the upper wheel shaft (1) U-joint assembly onto the lower wheel shaft. Ensure ithat the cross in the lower yoke of the universal joint is parallel to the pin in the lower wheel shaft.

4. Tighten the bolt (30), lock washer (29) and nut (28) on the U-joint to 35 ft. lbs. (47 Nm).

5. Assemble onto the upper wheel shaft the spacer collar (2), flat washer (3), cup washer (4), lower spacer (6), washer (8), nylon bushing (9) and lower bearing (14).

6. Install the contact ring (10) and connect the cable (11). Secure the cable to the contact ring with tape.

7. Slide the jacket tube (13) onto the wheel shaft (1) and install the contact brush (32).

8. Install the upper bearing (14), nylon bushing (9), washer (8), upper spacer (7) and spring (5) onto the jacket tube.

NOTE: When assembling bearings onto the jacket tube it may be necesasry to tap the top of the jacket with a rubber mallet.

INSTALLATION

1. Remove the two screws that secure the instrument panel and partially remove the panel to gain access to the U-clamp tapping plate.

2. Position the U-clamps around the jacket tube and align the tapping plate holes with the U-clamps. Thread the bolts into the tapping plate but do not tighten.

3. Lift the rubber cover off the flexible coupling and locate the hole beneath the bolt and lock washer. Insert a ¼" (6.35 mm) pin, or drill shank into the hole and lift up on the column assembly until it stops against the pin. Using vise grip pliers, clamp the lower shaft at the flexible coupling to hold the shaft in position against the pin.

4. Align and tighten the bolts on the U-clamps.

5. Slide the turn signal assembly over the steering column but do not secure.

6. Clean, degrease and apply "Locquic Primer T" to the column shaft threads and nut. Apply a film of "Loctite Stud Lock" to the shaft and nut. Mount the steering wheel in a straight ahead position and install the wheel nut using 50 ft. lbs. (68 Nm) of torque.

7. Remove vise grip pliers and pin.

8. Adjust and secure the turn signal assembly ensuring that it functions properly.

9. Install the contact brush wire on the left side of the steering column and connect the horn wires. Mount the steering wheel medallion ensuring that the logo is parallel and centered in the steering wheel cross member.

10. Install the instrument panel and lower steering column cover.

LUBRICATION

Grease the steering column U-joints at 5000 mile intervals using molybdenum disulphide grease. Remove steering column cover for access to grease fitting.

MC-9 MAINTENANCE MANUAL

HFB 70 INTEGRAL STEERING GEAR

The integral power steering gear incorporates a manual steering mechanism, a hydraulic control valve, and a hydraulic power cylinder. The control valve is a rotary type which directs oil flow from the engine driven power steering pump to either one of the cylinder cavities. The flow directed to a cylinder cavity is dependent upon the speed at which the steering wheel is turned. See figure 11-6.

Force on the steering wheel is transmitted to the steering gear input shaft. The input is connected to the worm shaft by means of a torsion bar. The torsion bar turns with the input shaft, exerting a rotational force on the worm shaft. The worm shaft in turn transmits the force through a ball nut mechanism to axial force on the rack piston. The rack piston resists this force due to its engagement to the sector shaft. With this resistance, the torsion bar is twisted by the input shaft. Pressurized fluid moves the rack piston axially through the cylinder bore and the rack piston then turns the sector shaft and steers the coach.

If the wheels receive a shock load, the shock force is transmitted through the sector shaft to the rack piston and on to the worm shaft. This force causes the control valve to send high pressure fluid to the proper cavity to resist the shock force. By hydraulically absorbing the shock, the steering gear prevents kickback at the steering wheel.

The steering gear is equipped with two unloading valves (poppets) at either end of the housing. As the steered wheels approach the axle stop, the corresponding poppet is opened. This reduces pressure in the gear and helps to reduce heat generated by the pump. The tripped poppet also reduces the load force on the steering linkage. These poppets may be adjusted by the adjusting screws on either end of the steering gear.

CENTERING STEERING

1. Center the steering gearbox by aligning the sector shaft timing mark (scribed line) at a 90 degree angle to the input shaft.

NOTE: The Pitman arm is installed on the sector shafts so the timing marks on the arm and shaft are aligned.

2. Adjust the drag link so that the wheels are straight ahead.
3. If necessary, remove the steering wheel and install it so that the cross pieces are at the 3 and 9 o'clock positions.

AXLE STOP ADJUSTMENT

1. Turn the wheels to the left until there is a minimum 1/16" (1.59 mm) clearance between the left steering arm and any possible contact surfaces.

2. Adjust axle stop screw to provide this clearance.

3. Turn the wheels to the right until there is a minimum 1/16" (1.59 mm) clearance between the right steering arm and any possible contact surfaces.

4. Adjust axle stop screw to provide this clearance.

MC-9 MAINTENANCE MANUAL

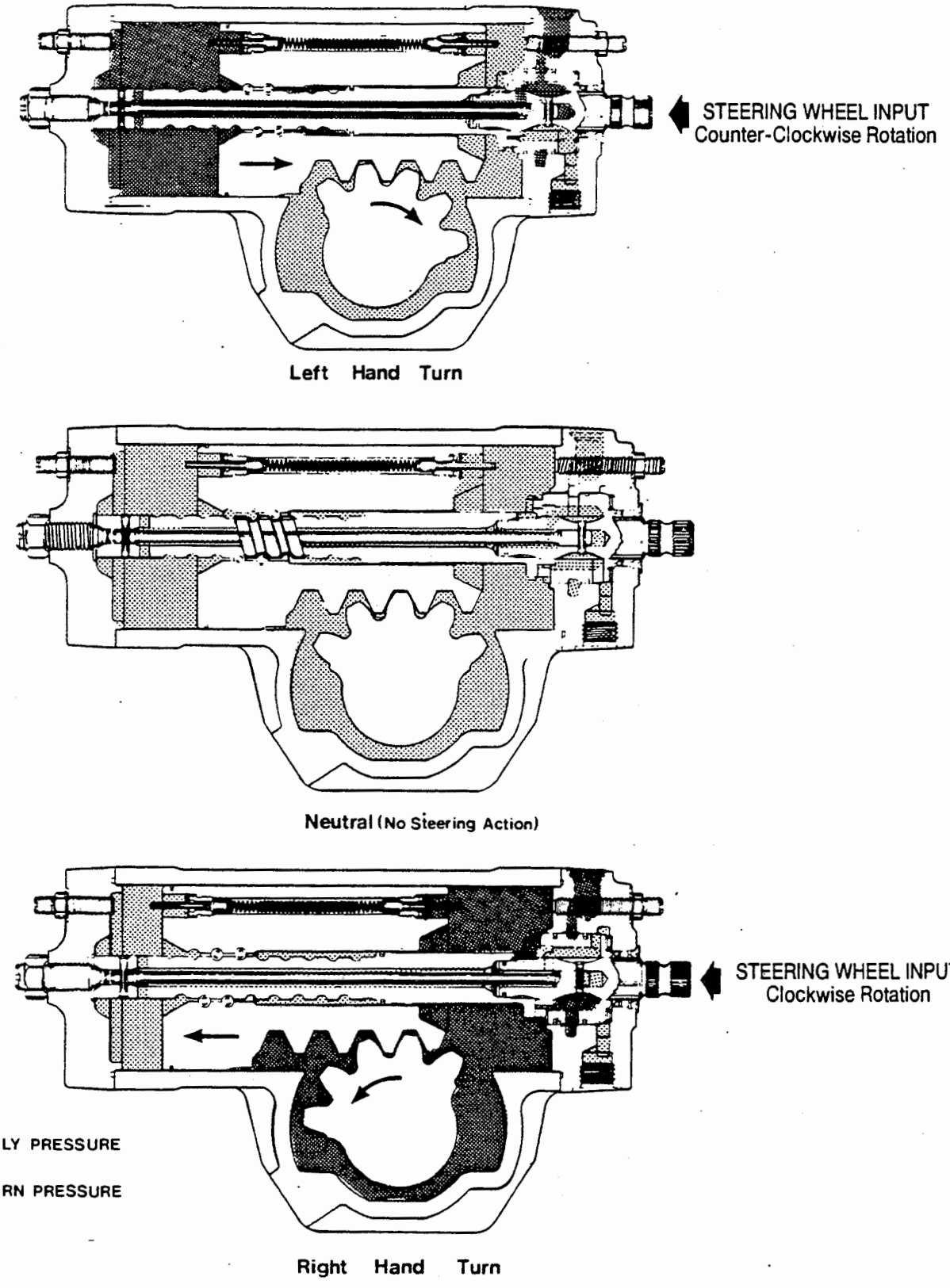


Figure 11-4. Steering Gear Oil Flow.

MC-9 MAINTENANCE MANUAL

POPPET VALVE ADJUSTMENT

1. Before adjusting the poppet valves make sure the axle stops are properly set, and the front wheels are on the floor.

2. Back off the adjusting screw jam nuts and turn the screws all the way into the gearbox.

3. Start the engine and let it idle.

CAUTION: When relief pressure is reached, the gear will produce a hissing sound. This is normal. However, do not hold the gear in this position for longer than five seconds. To do so will damage the pump.

4. Back out the bottom adjusting screw until the gearbox allows the axle to turn to within ⅛" (3.175 mm) of the right hand axle stop.

5. Tighten the jam nut to 12-18 ft. lbs. (16.3-24.4 Nm) torque.

6. Repeat this procedure for the left hand turn using the adjusting screw at the top of the gearbox.

NOTE: While tightening the jam nut, make sure that the adjusting screw does not move.

7. Check the clearance at the right hand stop to ensure that it has not changed. If it has, readjust the poppet.

REMOVAL OF STEERING GEAR (96A3/102A3/102C3)

1. Remove the steering column. (Refer to Removal of Steering Column.)

2. Remove the pinch bolt on the Pitman arm.

3. Drive a wedge into the groove at the top of the arm to loosen it from the sector shaft. Slide the Pitman arm off the shaft.

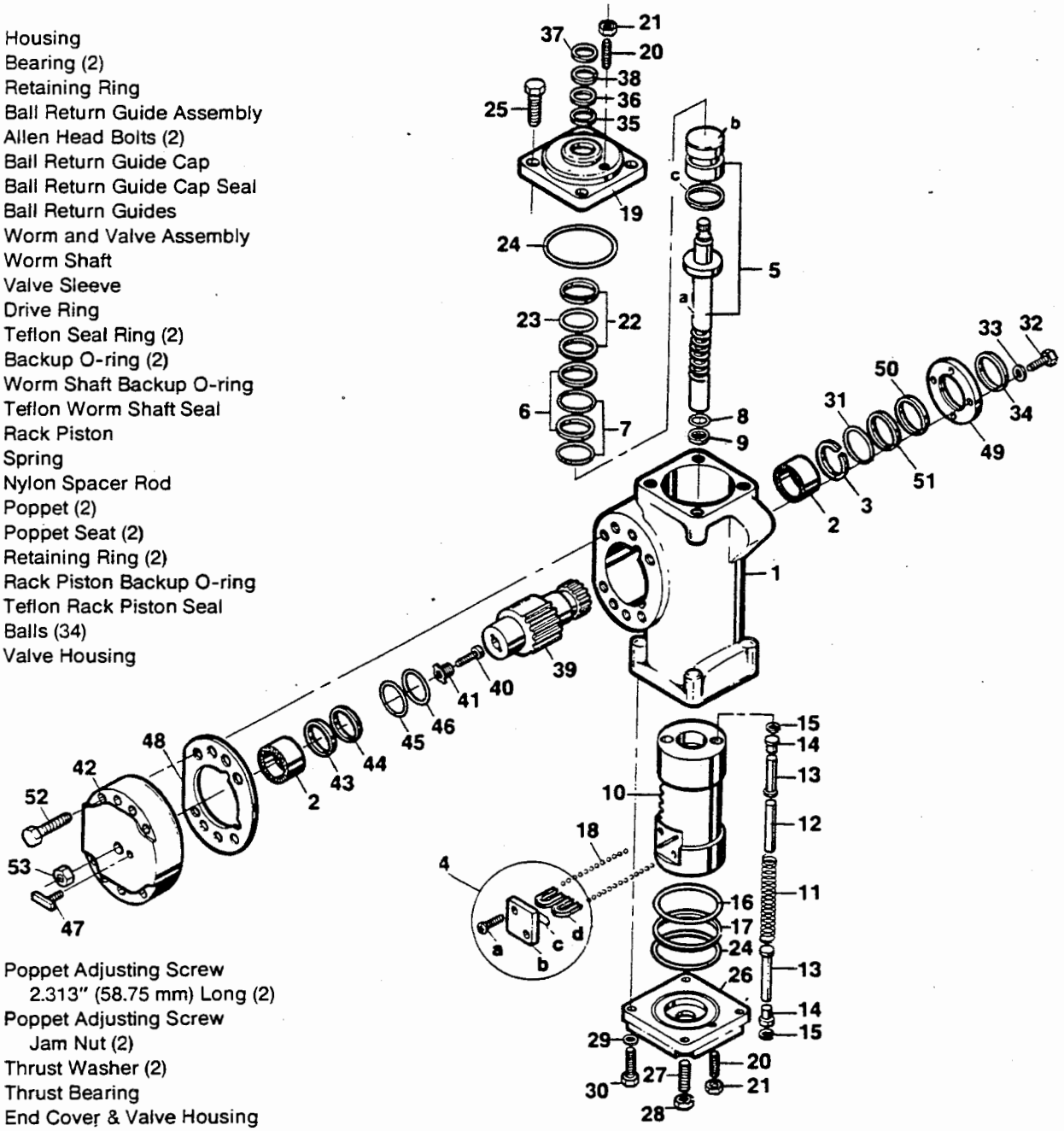
4. Clean the area around the fittings.

5. Disconnect the hoses and plug the holes to prevent contamination.

WARNING: The steering gear weighs approximately 110 lbs. (50 kg) dry. Before continuing with the removal procedure, support the gear to prevent it from falling from the frame after the mounting bolts have been removed.

6. Take out the bolts that mount the gear to the frame and carefully remove the gear.

MC-9 MAINTENANCE MANUAL



1. Housing
2. Bearing (2)
3. Retaining Ring
4. Ball Return Guide Assembly
4a. Allen Head Bolts (2)
4b. Ball Return Guide Cap
4c. Ball Return Guide Cap Seal
4d. Ball Return Guides
5. Worm and Valve Assembly
5a. Worm Shaft
5b. Valve Sleeve
5c. Drive Ring
6. Teflon Seal Ring (2)
7. Backup O-ring (2)
8. Worm Shaft Backup O-ring
9. Teflon Worm Shaft Seal
10. Rack Piston
11. Spring
12. Nylon Spacer Rod
13. Poppet (2)
14. Poppet Seat (2)
15. Retaining Ring (2)
16. Rack Piston Backup O-ring
17. Teflon Rack Piston Seal
18. Balls (34)
19. Valve Housing
20. Poppet Adjusting Screw 2.313" (58.75 mm) Long (2)
21. Poppet Adjusting Screw Jam Nut (2)
22. Thrust Washer (2)
23. Thrust Bearing
24. End Cover & Valve Housing O-ring (2)
25. Valve Housing Bolts 2.125" (53.98 mm) Long (4)
26. End Cover
27. Worm Shaft Preload Adjusting Screw
28. Worm Shaft Preload Adjusting Screw Jam Nut
29. End Cover Washer (4)
30. End Cover Bolts 1.625" (41.275 mm) Long (4)
31. Trunnion Cover O-ring
32. Trunnion Cover Bolts (4)
33. Trunnion Cover Washers (4)
34. Dirt & Water Seal
35. Input Shaft Seal
36. Steel Backup Washer
37. Retaining Ring
38. Dirt & Water Seal
39. Sector Shaft
40. Sector Shaft Adjusting Screw
41. Retainer
42. Side Cover
43. Steel Backup Washer
44. Teflon Backup Washer
45. Side Cover Seal (Two Piece)
46. Retaining Ring
47. Vent Plug
48. Side Cover Gasket
49. Trunnion Cover
50. Teflon Backup Washer
51. Sector Shaft Seal (Two Piece)
52. Side Cover Bolts (8)
53. Sector Shaft Adjusting Screw Jam Nut

Figure 11-5. Steering Gear.

MC-9 MAINTENANCE MANUAL

DISASSEMBLY OF STEERING GEAR

Throughout the disassembly and assembly instructions, key numbers are called out to aid in parts identification. These numbers refer to the exploded view of the steering gear (figure 11-5).

1. Drain steering gear and clean the outer surface.

CAUTION: Never steam clean or high-pressure wash any hydraulic steering components. Do not force or abuse closely fitted parts.

2. Position the steering gear in a vise with the worm shaft (5a) in a horizontal position.
3. Rotate the worm shaft to the end of the sector shaft (39) travel.
4. Position the timing mark on the sector shaft in a vertical direction (halfway between two capscrews). The steering gear is now in its center of travel.
5. Clean the serrated end of the sector shaft and loosen the jam nut (53) on the sector shaft adjusting screw (49) (figure 11-6).
6. Remove and discard the dirt and water seal (34) from the trunnion cover (49) (figure 11-7).

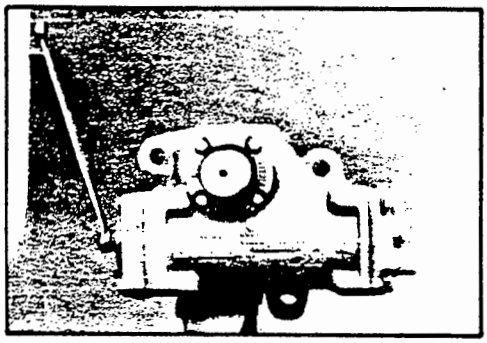


Figure 11-6. Loosening Sector Shaft From Nut.

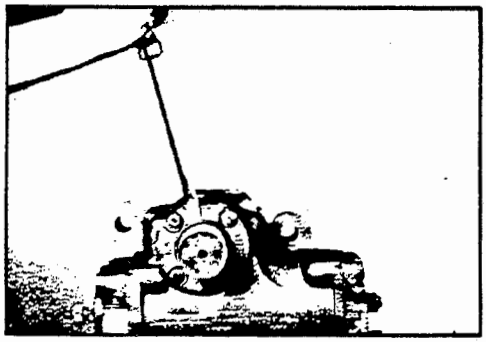


Figure 11-7. Removing Seal.

7. Remove the four bolts (32) from the trunnion cover with a ½ inch socket (figure 11-8).
8. Remove the trunnion cover (figure 11-10).
9. Turn the serrations and bolt groove of the sector shaft (figure 11-11).

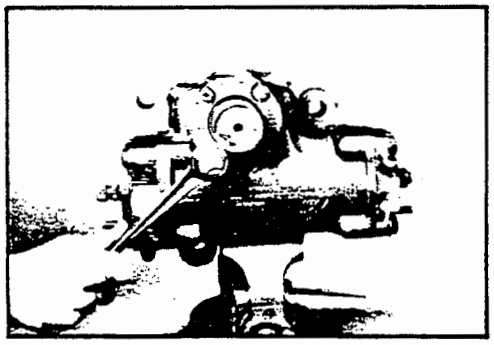


Figure 11-8. Bolt Removal.

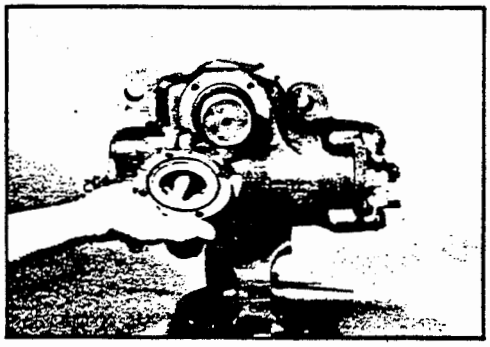


Figure 11-10. Trunnion Cover Removal.

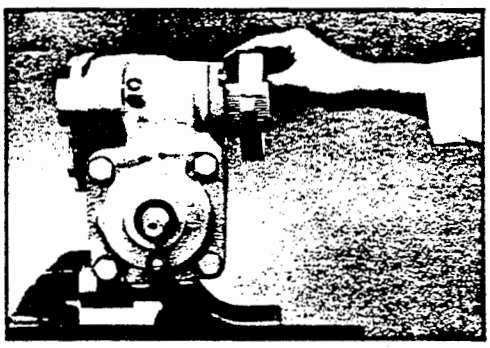


Figure 11-11. Applying Tape to Sector Shaft.

MC-9 MAINTENANCE MANUAL

10. Remove the eight special ring head bolts (52) from the side cover (42) with a 13/16 inch socket (figures 11-11 and 11-12). There will be some draining of fluid at this point.

NOTE: These eight bolts have a special sealing ring located on the underside of the bolt head. If it is necessary to replace any of these bolts, use only the same special type and length of bolts.

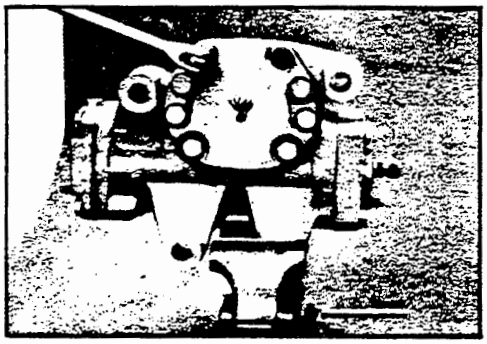


Figure 11-11. Removing Ring Head Bolts.

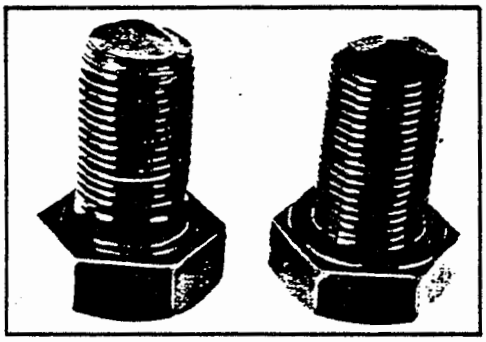


Figure 11-12. Ring Head Bolts.

11. Begin to remove the side cover (42) and sector shaft (39) assembly (figure 11-13) and stop when the bearing rollers are half exposed. A soft hammer may be needed to start the removal of the side cover sector shaft assembly.

NOTE: Exercise care in removing this assembly slowly. If the assembly is removed too quickly, it will be difficult to retain the bearing rollers in the race.

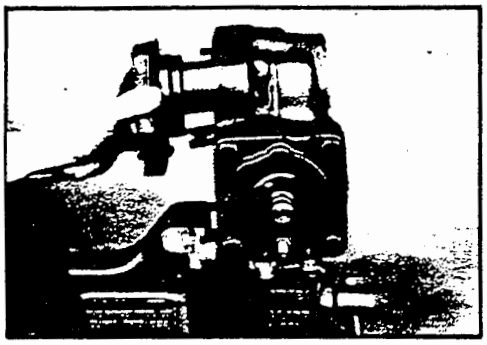


Figure 11-13. Sector Shaft Partial Removal.

12. When the rollers are half exposed, apply enough grease to retain them in the housing bearing (2) (figure 11-14).

CAUTION: If one or more of the bearing rollers is lost, it is necessary to replace the entire bearing.

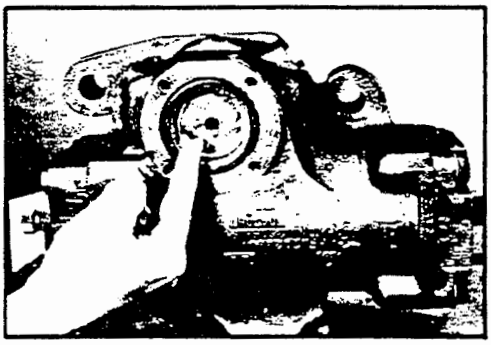


Figure 11-14. Apply Grease to Retain Bearing Rollers.

13. Complete removal of the side cover sector shaft assembly.

If the bearing is damaged, or it becomes necessary to replace the housing bearing (2), remove the bearing in the following manner: Using bearing mandrel J26743, apply pressure from the side cover opening and press the bearing out through the trunnion cover opening (figure 11-15). Care must be taken to maintain a good, square contact between the housing and press base to avoid damaging the bearing bore. If the bearing is cocked during removal, it may burnish the bore, causing it to become oversized and to require replacement of the steering gear housing.

CAUTION: The bearing may contain either 41 or 42 rollers, depending upon the type of bearing used. Bearing BR-970 has 41 rolls. Bearing BR-970-1 has 42 rolls. The bearing identification number is on the outside edge of bearing rollers inside the side cover with either 41 or 42 rollers. The quantity may not be the same as in the housing bearing. In any case, do not mix these rollers.

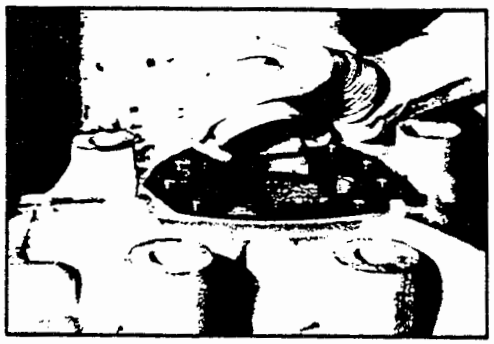


Figure 11-15. Removing Bearing.

MC-9 MAINTENANCE MANUAL

14. Remove the sector shaft adjusting screw jam nut (53) (figure 11-16).

15. Screw the sector shaft adjusting screw (40) through the side cover (42) (figure 11-17). Place the side cover exterior face down and lift the sector shaft out vertically.

CAUTION: Removal of the sector shaft will allow the side cover bearings to fall into the side cover cavity. Immediately collect and count all the side cover bearings at this time.

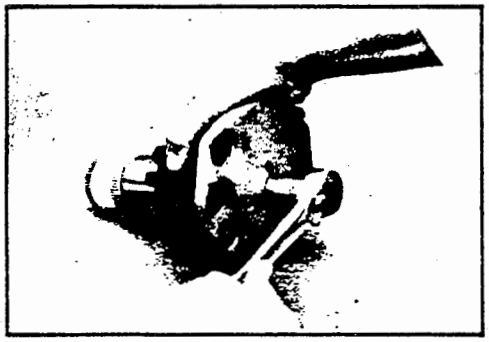


Figure 11-16. Removing Jam Nut.



Figure 11-17. Turning Adjusting Screw.

16. Remove the retaining ring (46) (figure 11-18), the two-piece side cover seal (45), the teflon backup washer (44), and the steel backup washer (43) from the side cover (figure 11-19). Discard the seal and the teflon washer.

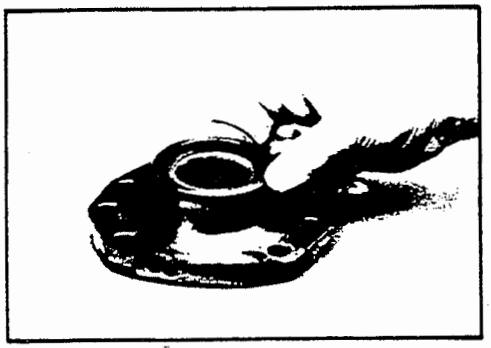


Figure 11-18. Retaining Ring Removal.

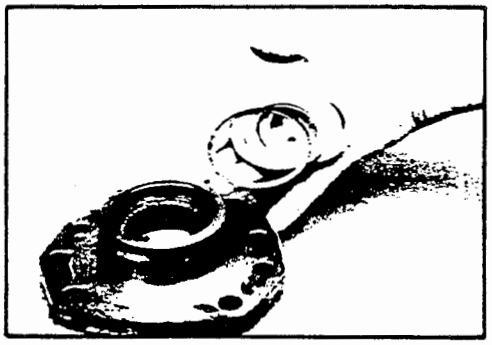


Figure 11-19. Rings and Washers Removal.

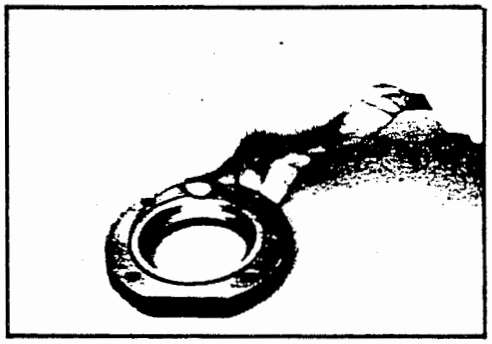


Figure 11-20. O-ring Removal.

17. Remove the trunnion cover O-ring (31) (figure 11-20), the two-piece sector shaft seal (51), and the teflon backup washer (50) from the trunnion cover (49) (figure 11-21). Discard seal, washer and O-ring.

18. Loosen the worm shaft adjusting screw jam nut (28) with 15/16 inch socket, and loosen the worm shaft preload adjusting screw (27) two turns with a 15/16 Allen socket or screwdriver (figure 11-22). Loosen the poppet adjusting screw jam nut (21) and the poppet adjusting screw (20) two turns.

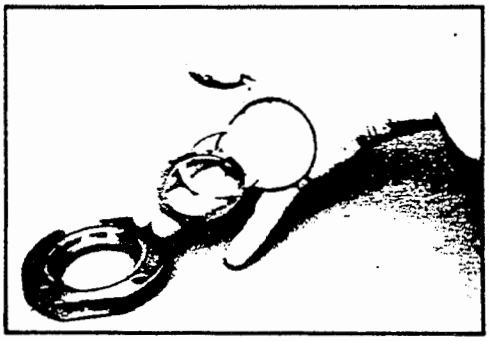


Figure 11-21. Seals and Washers Removal.

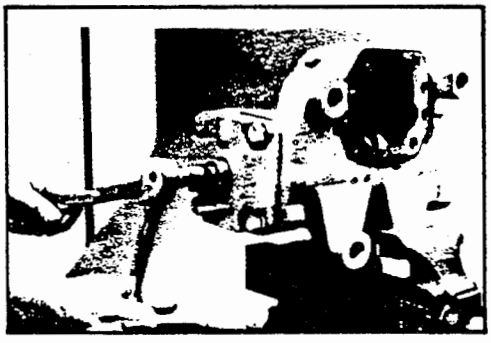


Figure 11-22. Loosening Adjusting Screw.

MC-9 MAINTENANCE MANUAL

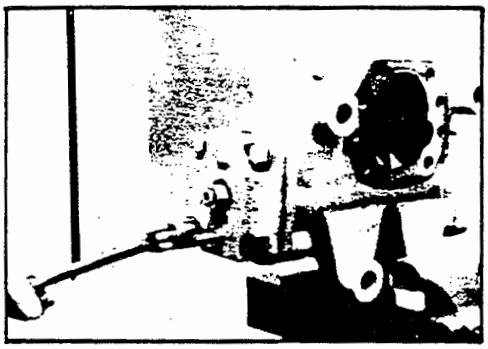


Figure 11-23. Removing Bolts.

19. Remove the four end cover bolts (30) with a 13/16 inch socket and remove the four washers (29) (figure 11-23).

20. Remove the end cover (26) (figure 11-24). Some fluid will drain at this point.

21. Remove and discard the end cover O-ring (24) from the end cover (26) (figure 11-25).

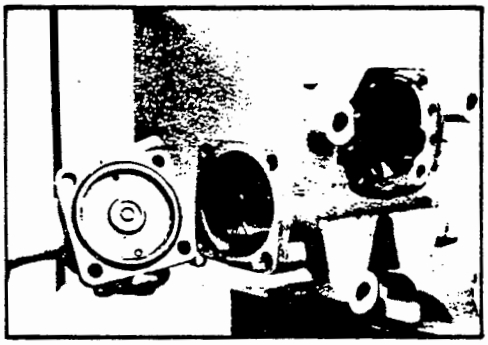


Figure 11-24. Removing End Cover.

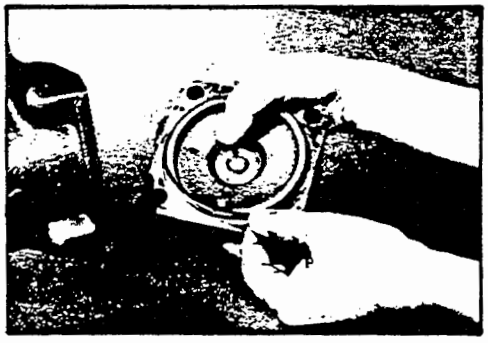


Figure 11-25. O-ring Removal.

22. Clean the input shaft with a fine grade emery paper (figure 11-26).

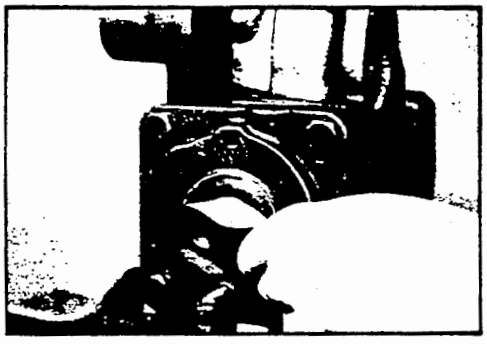


Figure 11-26. Cleaning Shaft.

23. Loosen the poppet adjusting screw jam nut (21) and the poppet adjusting screw (20) two turns.

24. Remove the four valve housing bolts (25) with a 13/16 inch socket (figure 11-27).

25. Remove the valve housing (19) (figure 11-28). Some fluid will drain.

NOTE: The valve sleeve (5b) will probably remain in the valve housing.

CAUTION: Do not remove the drive ring (5c) from the worm shaft (5a) or attempt to distort the tangs which hold the drive ring in place on the worm shaft. Doing either will alter the valve timing and could cause the coach to pull to one side after the steering gear is installed.

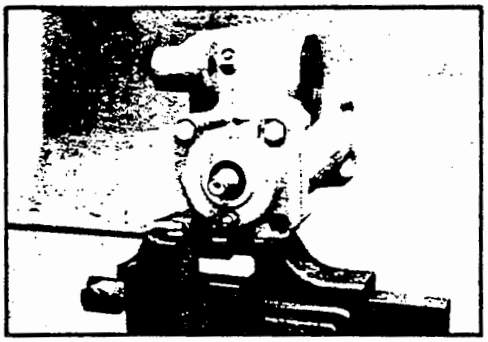


Figure 11-27. Housing Bolt Removal.

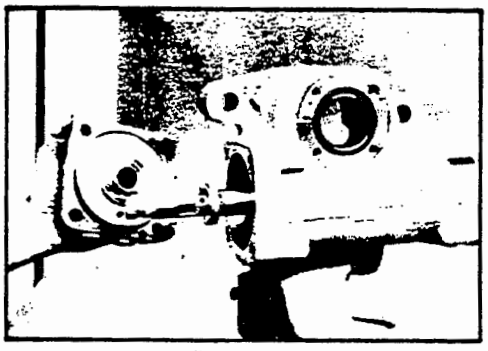


Figure 11-28. Valve Housing Removal.

26. Remove the valve sleeve (5b) from the valve housing (19) (figure 11-29).

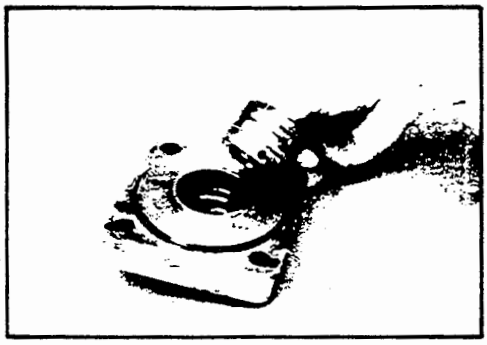


Figure 11-29. Removing the Valve Sleeve.

27. Remove the first thrust washer (22), the thrust bearing (23), and the second thrust washer (22) from the valve housing (figure 11-30).

NOTE: The second thrust washer may remain on the end of the valve sleeve.

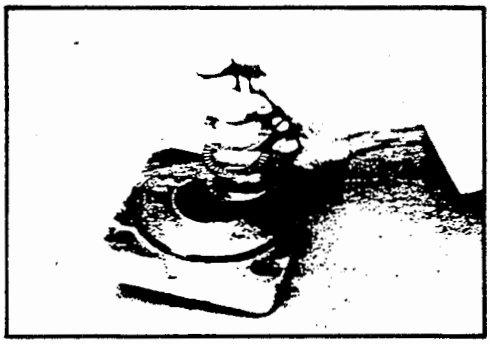


Figure 11-30. Washer and Bearing Removal.

28. Remove and discard the valve housing O-ring (24) from the valve housing (19).

29. Remove and discard the dirt and water seal (37) (figure 11-31).

30. Remove the retaining ring (38) (figure 11-32).

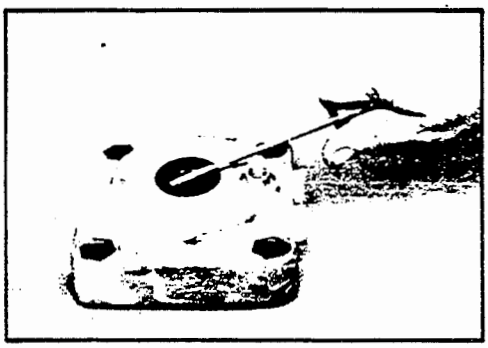


Figure 11-31. Seal Removal.

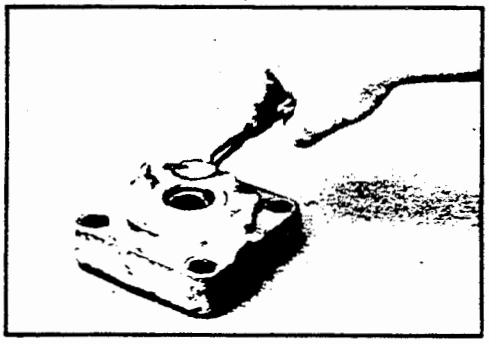


Figure 11-32. Retaining Ring Removal.

31. Remove the steel backup washer (36) and the two-piece input shaft seal (37) from the valve housing (figure 11-33). Discard the seal.

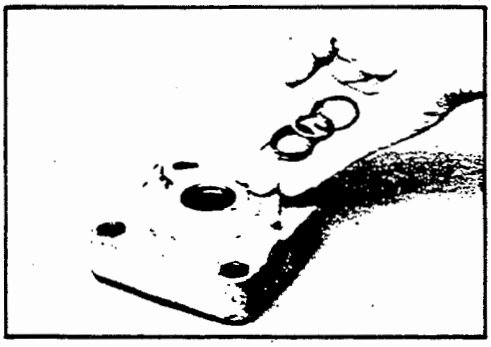


Figure 11-33. Seal and Washers Removed.

32. Remove and discard the two teflon seal rings (6) from the valve sleeve (figure 11-34).

33. Remove the two backup O-rings (7) (figure 11-35) from the valve sleeve grooves.



Figure 11-34. Removing Teflon Ring.

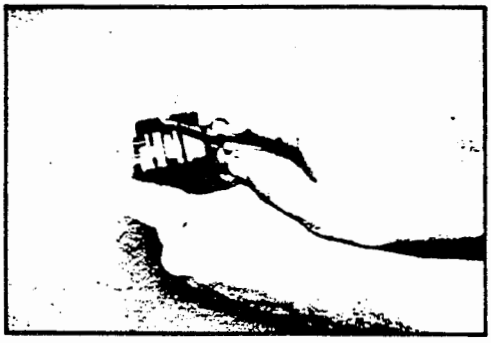


Figure 11-35. Removing O-rings.

34. Remove the rack piston (10) worm shaft (5a) assembly from the gear housing (figure 11-36).

CAUTION: The worm shaft will be inside the rack piston with the input part of the worm protruding from the rack piston. When removing the assembly from the housing, take care to prevent the teflon rack piston seal (17) from getting caught in the sector shaft cavity. Remove the assembly from the long end of the housing.

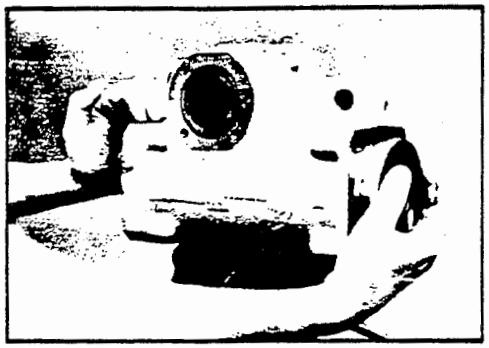


Figure 11-36. Removing the Rack Piston.

35. Place the rack piston worm shaft assembly on a clean cloth to prevent the piston from rolling.

36. Remove the two Allen head bolts (4d) (Figure 11-37) from the ball return guide cap (4e); remove the ball return guide cap (Figure 11-38) and the ball return guide cap seal (4f).

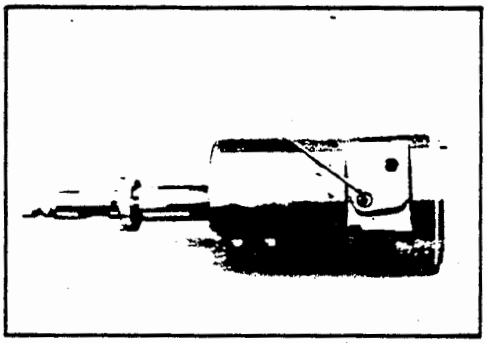


Figure 11-37. Allen Head Bolt Removal.

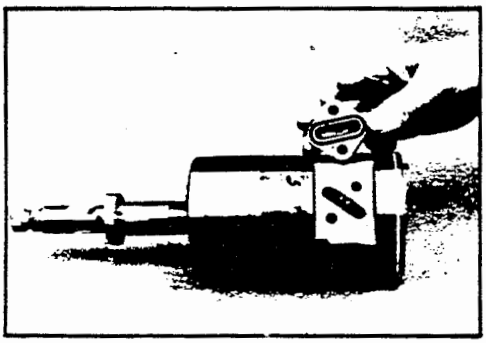


Figure 11-38. Removing Guide Cap.

37. Remove the two ball return guides (4c or 4g) (figure 11-39) and the balls (18) from the rack piston (10) by rotating the worm shaft (5a) until the balls fall out (figure 11-40).

NOTE: Ball return guides are closely fitted with the rack piston and you may have to remove them by carefully inserting a screwdriver between the rack piston and ball return guides.

CAUTION: Assembly contains a set of 34 matched balls, and you must take special care not to lose any. If any balls are lost, a complete, new set of matched balls will be required.

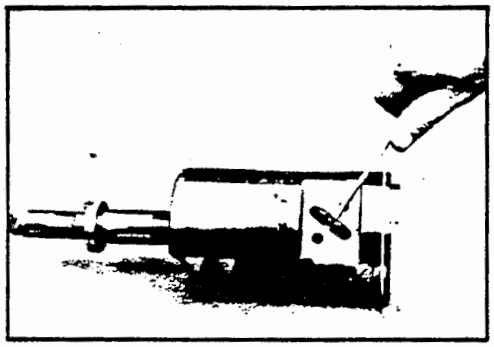


Figure 11-39. Loosening Ball Return Guides.

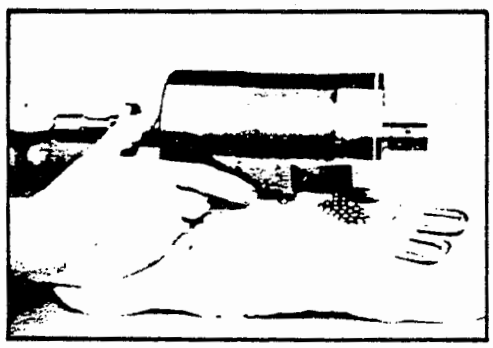


Figure 11-40. Removal of Balls.

MC-9 MAINTENANCE MANUAL

38. Remove the worm shaft (5a) from the rack piston (10) (figure 11-41).

39. Remove and discard the rack piston seal ring (17) (figure 11-42).

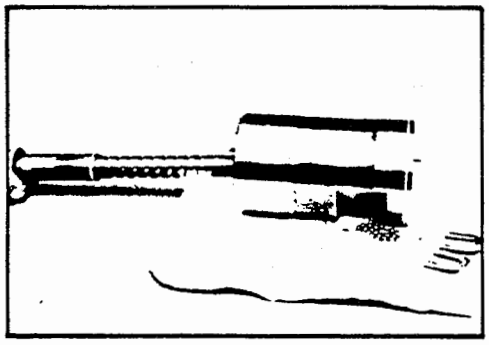


Figure 11-41. Removing Worm Gear.

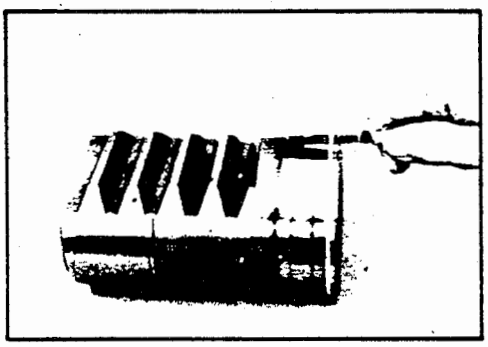


Figure 11-42. Seal Ring Removal.

40. Remove and discard the rack piston backup O-ring (16) (figure 11-43) from the rack piston.

41. Remove and discard the worm shaft seal ring (9). Then, remove and discard the worm shaft O-ring (8) from the worm shaft (figure 11-44).

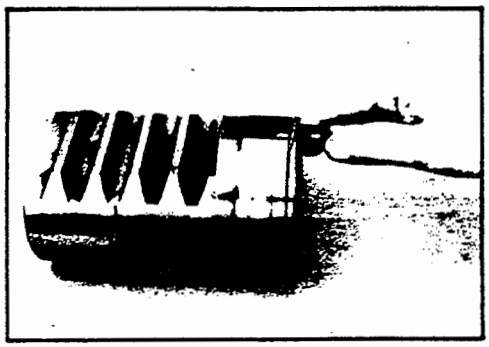


Figure 11-43. O-ring Removal.

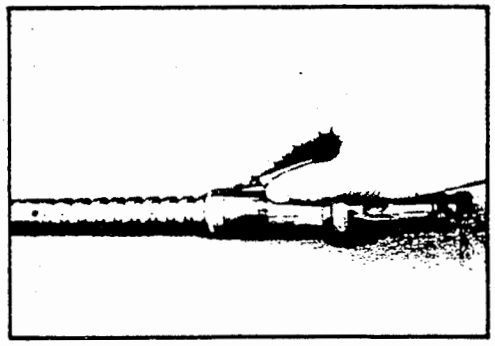


Figure 11-44. Removing Seal Ring.

42. It is not usually required to service the poppet assembly. If required, however, position the rack piston (10) carefully in a vise equipped with soft jaws. Then remove two retaining rings (15) (figure 11-45), two poppet seats (14) (figure 11-46), two poppets (13), nylon spacer rod (12), and spring (11) (figure 11-47).

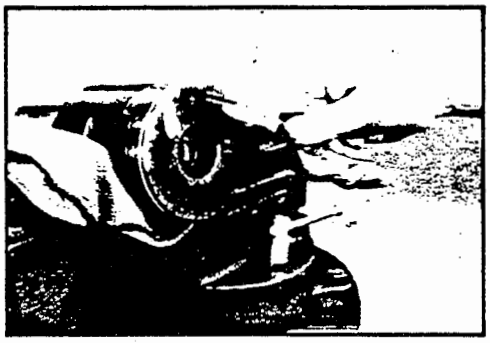


Figure 11-45. Retaining Ring Removal.

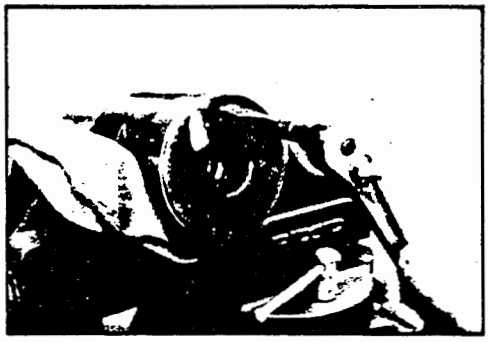


Figure 11-46. Poppet Seal Removal.

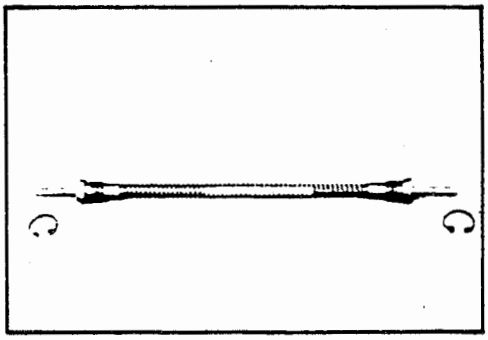


Figure 11-47. Poppets, Rod and Spring.

INSPECTION

All sealing surfaces and seal cavities must be free from nicks and corrosion. If you detect any nicks or corrosion, you must replace the part to ensure proper sealing. Before you inspect the steering gear, wash all parts in clean, clear solvent and blow dry with compressed air.

1. Inspect rack piston (10) teeth for cracks and wear. If you can detect a step by running your fingernail edge horizontally across the teeth surface, replace the rack piston.

2. Inspect the rack piston ball track grooves (helical shaped) for brinelling (dents) or spalling (flakes) (figure 11-48). If either condition exists, the rack piston (10), valve sleeve (5b), sector

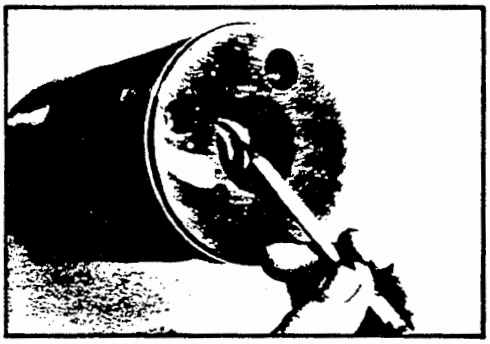


Figure 11-48. Location of Ball Track Grooves in Rack Piston.

shaft (39) and worm shaft (5a) must all be replaced.

3. Inspect the worm shaft (5a) ball track grooves (helical shaped) for brinelling or spalling. See figure 11-49 for an example of how ball sits properly on the track and normal machine marks on the shaft.

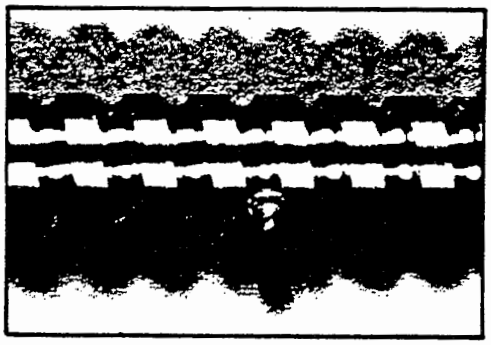


Figure 11-49. Worm Shaft with Ball in Track.

4. Visually inspect the upper input shaft seal area near serrations for nicks, and run your fingernail edge across the sealing surface to detect steps.

> **NOTE: The input shaft is pinned to the worm shaft by a torsion bar pin, and the worm shaft/input shaft assembly is flexible at this joint. As a result, the assembly may be slightly bent at this joint. This slight bend is normal.**

As you inspect the housing cylinder bore, you will notice scoring marks running lengthwise through the bore. This scoring is normal. The scoring in the steering gear cylinder should not be compared to the scoring you might see in the cylinder bores of an internal combustion engine.

5. Check the housing (1) faces for nicks which would prevent proper sealing. Replace the housing if these nicks are present (figure 11-50).

6. Inspect the housing bearing (2) for brinelling or spalling (figure 11-51). If either condition exists, or if one or more of the rollers is lost, replace the bearing (figure 11-53).



Figure 11-50. Inspect for Nicks.

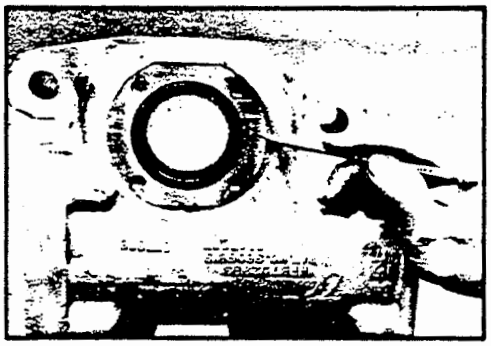


Figure 11-51. Inspect Housing Bearing.

7. Inspect the sector shaft (39) bearing sealing areas for brinelling or spalling. Run your fingernail edge across these areas to detect steps. Inspect for cracks. If any of these conditions exist, replace the sector shaft (figure 11-52).

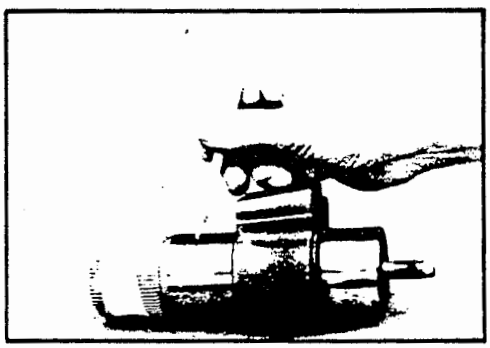


Figure 11-52. Shaft Bearing Seal Area.

8. Inspect the thrust bearing rollers (23) for any deterioration. Inspect the two thrust washers (22) for brinelling, spalling or cracks. Replace any part if you detect these conditions (figure 11-53).

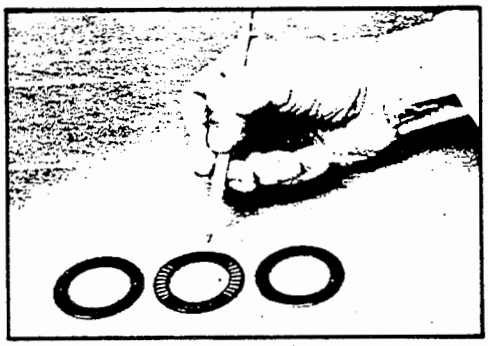


Figure 11-53. Thrust Bearing and Washers.

ASSEMBLY

Once you have completed your inspection and are ready to assemble the gear (including new parts, if necessary), wash all parts again in clean, clear solvent and blow dry. All gaskets, seals and seal rings must be replaced with new ones each time the gear is disassembled. Replace those gasket seals and seal rings with seal kits (figure 11-54).

1. Using seal installation tool J26739, assemble the new worm shaft backup O-ring (8) (figure 11-55), then the new teflon worm shaft seal (9) into the worm shaft ring groove (figure 11-56).

2. Compress the seal with seal compression tool J26740, and set the worm shaft aside for 10 minutes (figure 11-57).

NOTE: Allow for time to ensure that the ring and seal are properly seated when you assemble the worm shaft into the rack piston. If you do not allow for this time, the seal may break when you put the worm shaft into the rack piston.

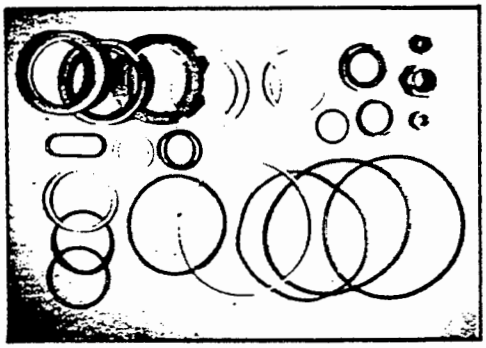


Figure 11-54. Seal Kit Contents.

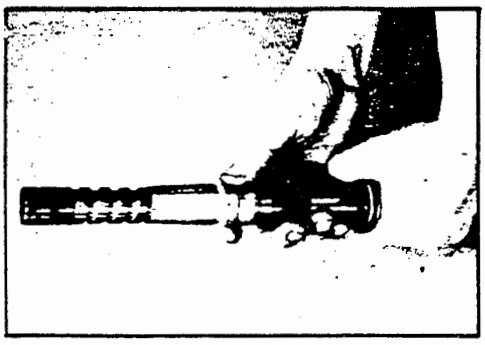


Figure 11-55. Installing O-ring.

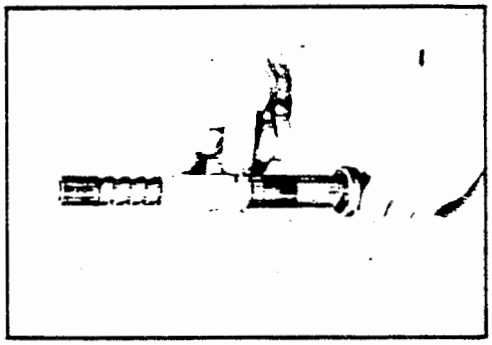


Figure 11-56. Installing Teflon Seal.

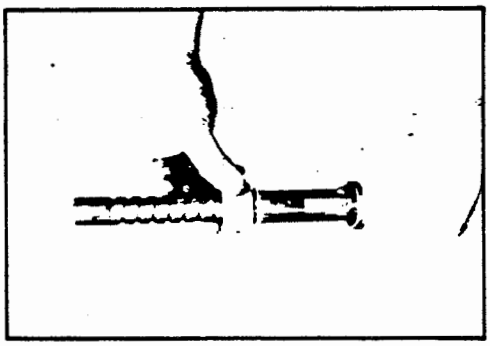


Figure 11-57. Use of Compression Tool.

3. Apply a generous amount of clean wheel bearing grease to the bearing race to retain the bearing rollers. Assemble either 41 or 42 rollers, depending on the type of bearing used (41 rollers - BR970; 42 rollers - BR-970-1). Grease must retain rollers.

CAUTION: Rollers must be in place to ensure proper installation of bearing. If rollers are not in place, bearing race may collapse and fail. The flange may become damaged or broken, causing premature bearing failure. Again, do not mix housing bearing rollers with side cover bearing rollers.

4. If required, press the new housing bearing (2) into the housing from side cover, using bearing mandrel J26743 (figure 11-58). Care must be taken during this procedure to make certain that the housing is square with the press base and that the bearing is not cocked.



Figure 11-58. Installing Housing Bearing.

5. Install the new rack piston backup O-ring (16) (figure 11-59), the new teflon rack piston seal ring (17) (figure 11-60) into the rack piston (10) ring groove. Do not stretch the rings as you install them. Coat with a liberal amount of grease.

WARNING: During the following step, you should wear eye protection.

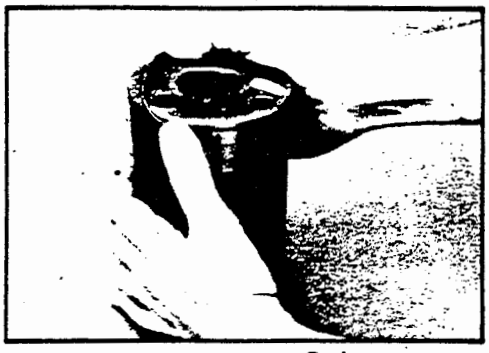


Figure 11-59. New O-ring.

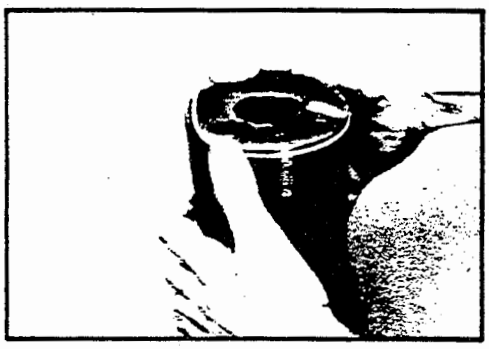


Figure 11-60. New Seal Ring.

6. If the poppets were removed, then install into the rack piston (10) one poppet seat (14), one poppet (13), the spring (11), the nylon spacer rod (12), the other poppet (13), and the other poppet seat (14). Tighten both poppet seats to 20-25 ft. lbs. (27.1-33.8 Nm) torque. Install both retaining rings (30) (figures 11-61, 11-62, 11-63).

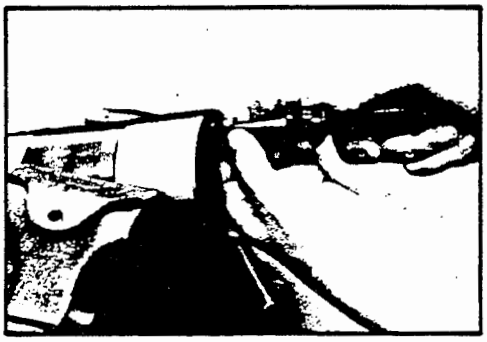


Figure 11-61. Installing Poppet Seat.

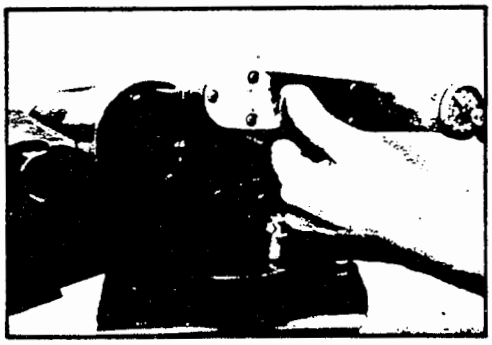


Figure 11-62. Tightening Seat.



Figure 11-63. Retaining Ring Installation.

7. Grease the seal ring cavity in the rack piston (10) and install the worm shaft (5a) into the rck piston (figure 11-67).

8. Assemble the ball return guides (4c) into the rack piston (10). Make sure that the ball return guides are seated.

WARNING: Make sure the ball return guides stay down in place while you assemble the balls. Failure to hold the guides down may result in a ball being trapped outside the closed loop. A trapped ball can result in a steering lockup.

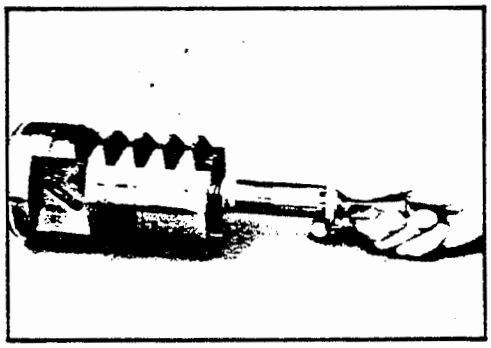


Figure 11-64. Installing Worm Shaft.

9. Assemble 34 balls (18) into the ball return guides (4c) and rack piston (10). Drop the balls through the hole provided in the ball return guides. As you drop the balls, rotate the worm shaft (5a) to pull the balls down into the grooves (figure 11-65).

MC-9 MAINTENANCE MANUAL

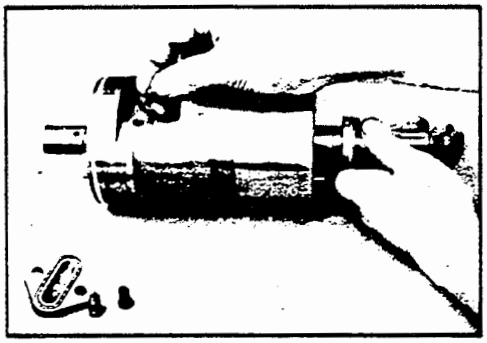


Figure 11-65. Ball Insertion.

10. Grease the ball return guide cap seal (4f) and place it in the ball return guide cap (4e) groove. Assemble the ball return guide cap so that the seal is in full contact with the rack piston (10) surface (figure 11-66). Install the two Allen head bolts (4d) and tighten them to 15-19 ft. lbs. (20-26 Nm) (figure 11-67).

11. Rotate the worm shaft from end of travel to end of travel, to make certain that you have installed the balls properly.

WARNING: If you cannot rotate the shaft, you will have to remove the balls and reassemble them. If you install the gear on a coach with shaft unable to rotate, the gear will not function.

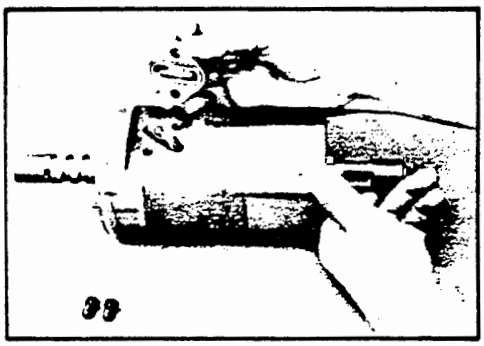


Figure 11-66. Installing Guide Cap Seal.

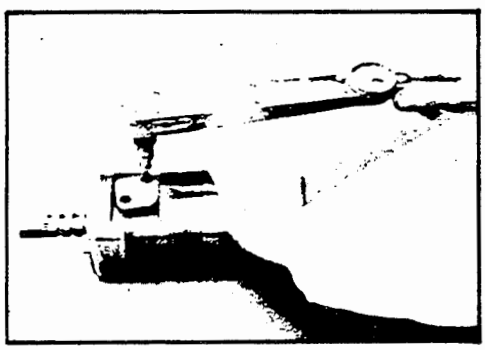


Figure 11-67. Bolt Tightening.

12. Apply a generous amount of clean grease to the Teflon rack piston seal (17) (figure 11-68), and to the housing cylinder bore.

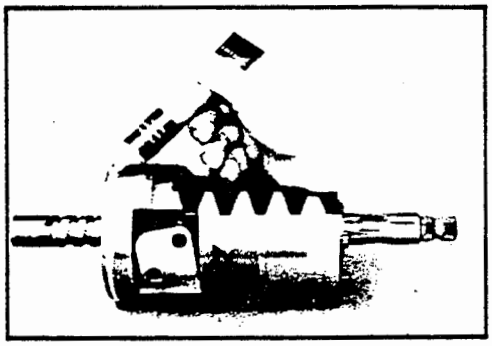


Figure 11-68. Grease Piston Seal.

13. Install the rack piston (10) worm shaft (5a) assembly into the long end of the housing (1) so that the Teflon rack piston seal goes in last (figure 11-69).

CAUTION: Be certain that the seal enters the long end last; otherwise, a large section of the seal will be cut and the coach will have no power steering assist.

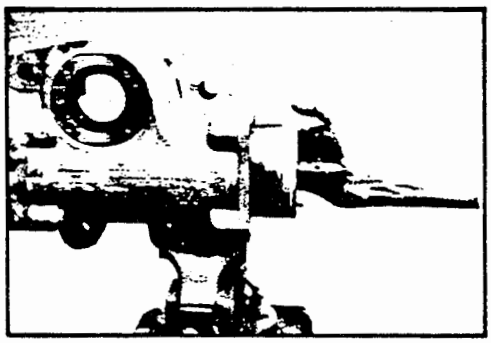


Figure 11-69. Piston and Shaft Assembly Installation.

14. To ease the later assembly of the sector shaft (39), rotate the rack piston worm shaft assembly in the housing so that the rack piston teeth are exposed in the sector shaft cavity of the housing.

15. Assemble the worm shaft adjusting screw jam nut (28) onto the solid (nonslotted) end of the worm shaft preload adjusting screw (27) so that the seal on the jam nut faces the end cover (26). Assemble the poppet valve adjusting screw jam nuts (21) onto the poppet valve adjusting screws (20) in the same manner as described for parts (27) and (28).

16. If the poppet valve adjusting screws are not the same length, assemble the shorter adjusting screw (20) 92.25 in./5.715 cm long) into the end cover (26) a few turns.

WARNING: If the screws are of unequal length, you must install the shorter screw into the end cover. Otherwise, the poppet assembly may break and cause the steering gear to lock up.

17. Assemble the worm shaft preload adjusting screw (27) into the end cover (26) a few turns. Final adjustments will be made later.

18. Apply clean grease to the end cover O-ring groove on the end cover (26). Install the new end cover O-ring (24) into the end cover O-ring groove (figure 11-70).

NOTE: When installed, the end cover O-ring should extend slightly above the machined surface of the end cover.

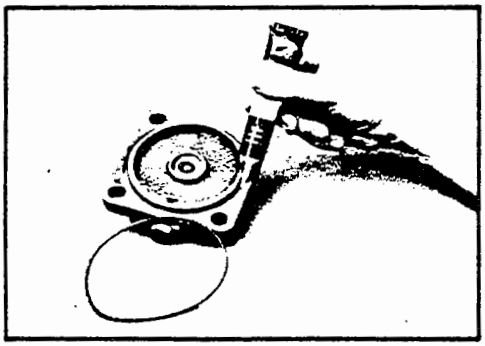


Figure 11-70. Applying Grease to O-ring Groove.

19. Make sure that the rack piston (10) teeth are fully visible in the sector shaft cavity of the housing. This is necessary to ensure proper location of the poppets, and to ensure that the poppet adjusting screw will contact the poppets.

20. Position the end cover (26) so that the poppet adjusting screw (20) is aligned with the end of the poppet (13) (figure 11-71).

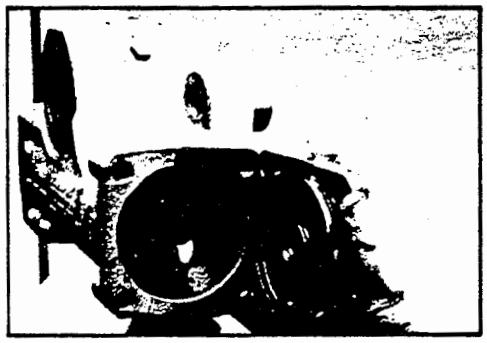


Figure 11-71. Positioning End Cover.

21. Install the four end cover bolts (30) and washers (29) and tighten the bolts to 145-155 ft. lbs. (196-210 Nm) torque (figure 11-72).

22. Grease the two new backup O-rings (7) and the two new Teflon seal rings (6). Using seal installation tool J26741, assemble the backup O-rings (figure 11-73), then the Teflon seal rings into the valve sleeve (5b) (figure 11-74).

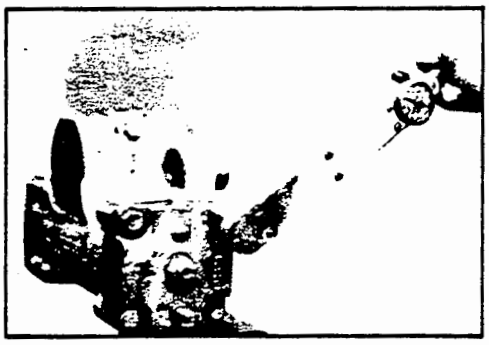


Figure 11-72. Tightening End Cover Bolts.

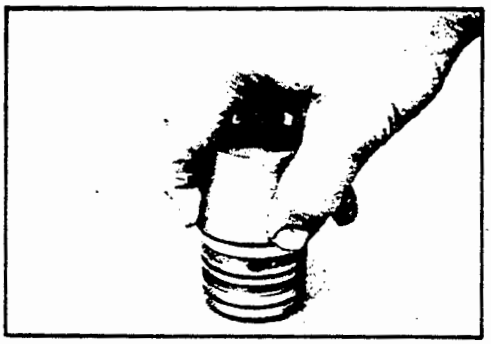


Figure 11-73. Installing O-rings.

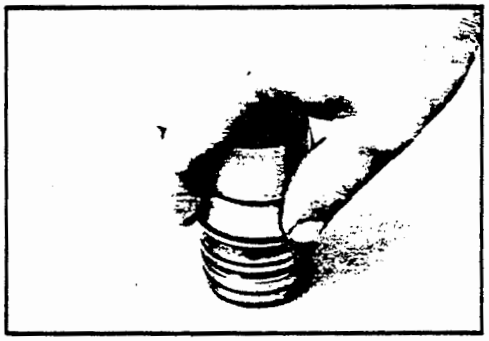


Figure 11-74. Installing Seal Rings.

23. Use compression tool J26742 to compress the Teflon seal rings (figure 11-75). Leave the compression tool in place for 10 minutes.

NOTE: If you do not allow for this compression time, the valve sleeve assembly will be difficult to assemble into the valve housing.

24. Assemble the poppet valve adjusting screw (20) into the valve housing (19) 4 or 5 turns. Final adjustment will be made later.



Figure 11-75. Compressing Seal Rings.

25. Apply clean grease to the valve housing (19) O-ring groove. Install the new valve housing O-ring (24) into the valve housing O-ring groove (figure 11-76).

NOTE: When installed, the valve housing O-ring should extend slightly above the machined surface of the valve housing.

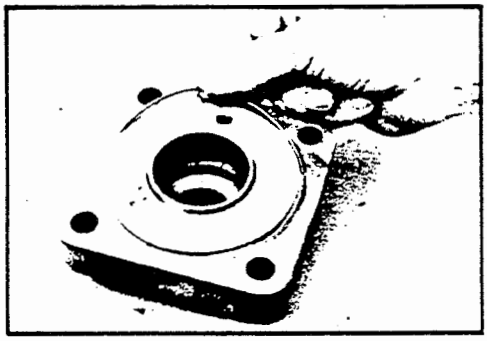


Figure 11-76. O-ring Installation.

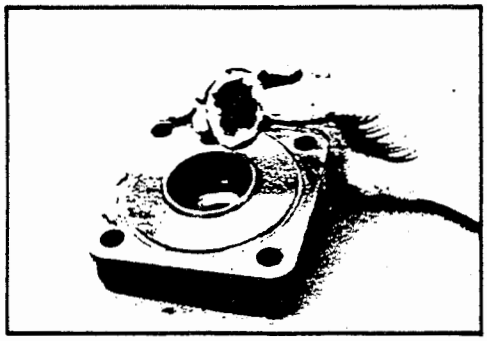


Figure 11-77. Installing Thrust Washer.

26. Apply a generous amount of clean grease to one thrust washer (22). Install the thrust washer into the valve housing (19), making sure to center the thrust washer in the counterbore (figure 11-77).

27. Apply a generous amount of clean grease to the thrust bearing (23). Install the thrust bearing into the valve housing (onto the thrust washer), making sure to center the bearing on the washer (figure 11-78).

WARNING: The thrust washer and thrust bearing must be flat and centered in the counterbore surfaces. Otherwise, the thrust washer could break when you assemble the valve housing into the gear housing (1). A broken washer could cause uncontrollable steering.

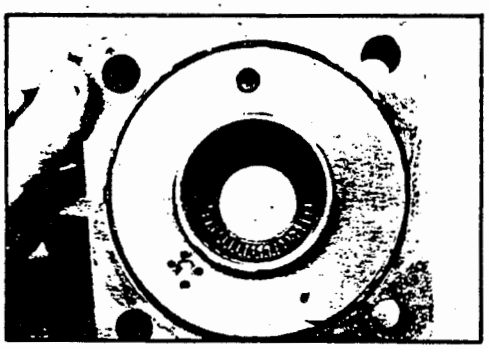


Figure 11-78. Bearing Centered in Counterbore.

28. Remove the compression tool J26742 from the valve sleeve (5b). Apply more grease to the valve sleeve seals, and grease the thrust washer face on the end of the valve sleeve without the drive slots. Place the other thrust washer (22) onto the valve sleeve end without the drive slots (figure 11-79).

WARNING: This thrust washer must be secure on the valve sleeve. If not, it can break and cause uncontrollable steering.

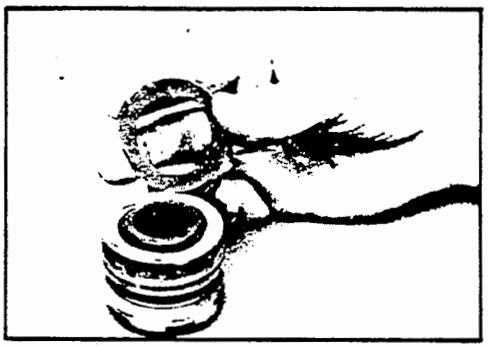


Figure 11-79. Placing Thrust Washer on Valve Sleeve.

29. Assemble the valve sleeve (5b) with attached thrust washer down into the valve housing (19) (figure 11-80).

30. Measure height of valve sleeve to face of valve housing (figure 11-81); should be .370-.400" (.929-1.01 cm). If not as required, repeat steps 25 thru 33.

WARNING: Do not force valve sleeve down into valve housing. Make sure valve sleeve seal rings are compressed. Misassembly or incorrect measurement may cause the thrust washers or thrust bearing to break during gear operation, which will result in uncontrollable steering.

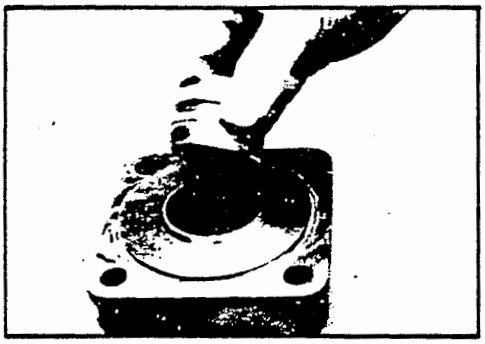


Figure 11-80. Valve Sleeve into Valve Housing.

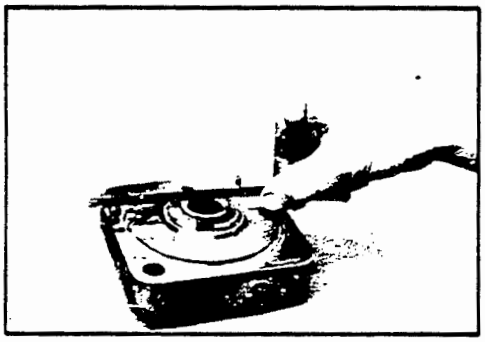


Figure 11-81. Checking Height of Valve Sleeve.

31. Position the rack piston (10) so that it is flush with the open end of the gear housing (1). Rotate the worm shaft (5a) until it extends out of the rack piston as far as it will go.

WARNING: Worm shaft and valve sleeve units are manufactured and sold as matched sets. Use only prematched sets for replacement. Never mate an old sleeve with a new worm or an old worm with a new sleeve. To do so may damage the gear or injure the driver, or both during operation.

32. Locate the timing mark on the valve sleeve (5b): a faint, punched mark on the chamfered edge of the valve sleeve (figure 11-82).

33. Locate the scribed timing mark on the worm shaft. (See igure 11-83.) Next, grasp the valve housing/valve sleeve ssembly with your thumbs on the valve housing face and your fingers applying pressure to keep the valve sleeve in the valve housing (figure 11-84).

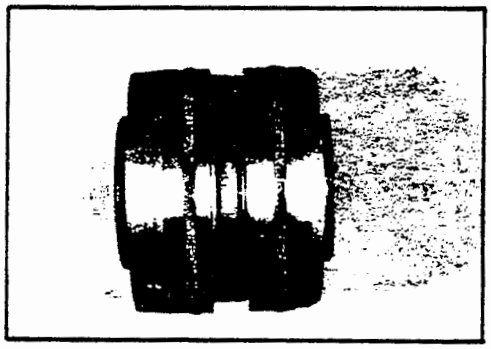


Figure 11-82. Valve Sleeve.

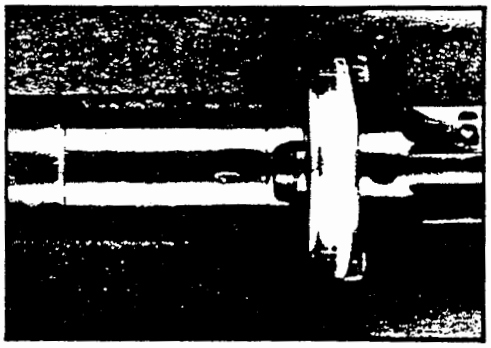


Figure 11-83. Worm Shaft Timing Mark.

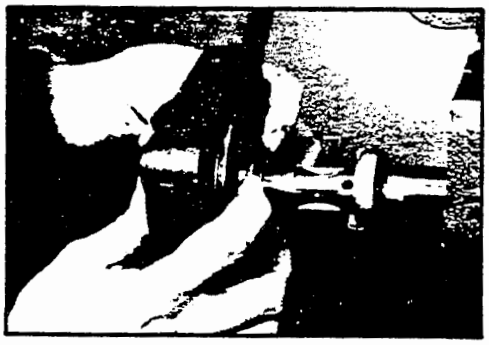


Figure 11-84. Positioning Housing/Sleeve Assembly.

34. Align the previously located timing marks and place the valve housing/valve sleeve assembly onto the input shaft end of the worm shaft until the drive lugs are fully engaged (figure 11-85).

NOTE: Valve sleeves are identified and matched to the right or left hand lead of the worm screw. If the screw has a right hand thread (that is, goes into the rack piston when turned clockwise), then the correct valve spool will have the letter "R" stamped between the lands. For a left hand worm lead (which will come out of the rack piston when turned clockwise), the valve spool has no identifying mark between the lands.

WARNING: If an incorrect valve spool is placed on a worm and assembled into the gear, the gear will malfunction by turning the steering wheel with such force that it could injure the driver.

MC-9 MAINTENANCE MANUAL

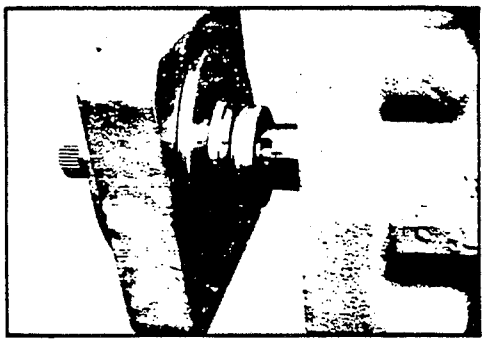


Figure 11-85. Housing and Sleeve Assembled on Worm Shaft.

35. Maintain pressure on the valve end of the valve housing to ensure continued engagement of the drive lugs and thrust bearing package (figure 11-86). While maintaining pressure, rotate the valve housing to align the poppet adjusting screw with poppet in the rack piston. Continuing pressure, rotate the input shaft to bring the valve housing into contact with gear housing face.



Figure 11-86. Installing Valve Housing Assembly.

36. Assemble four valve housing bolts (25) into the housing (1) and tighten to 145-155 ft. lbs. (196-210 Nm) torque (figure 11-87).

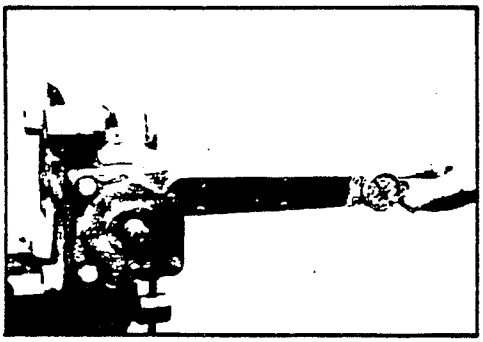


Figure 11-87.

37. Apply a generous amount of clean wheel bearing grease (do not substitute another type of grease) to the bearing race inside the side cover (42).

CAUTION: Use only wheel bearing grease. This bearing is sealed and will receive no lubrication from the hydraulic fluid in the gear. Failure to use wheel bearing grease could result in premature steering gear failure.

NOTE: You will have 41 or 42 rollers to assemble into the side cover bearing: 41 rollers - BR-970; 42 rollers - BR-970-1. Do not mix these rollers for the side cover with the rollers for the trunnion cover side of the gear housing.

38. Assemble 41 or 42 rollers into the side cover bearing race. Grease must retain rollers (figure 11-88).

39. Assemble the steel backup washer (43), the new Teflon backup washer (44), and the new two-piece side cover seal (45)

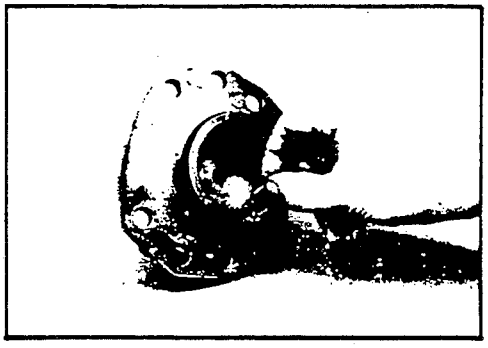


Figure 11-88. Installing Rollers.

into the side cover (42). Assemble two-piece seal so that words "oil side" are visible (figure 11-89).

CAUTION: The words "oil side" must be visible once the seal is in place. Otherwise, the seal will not function, which could result in a loss of power steering assist.

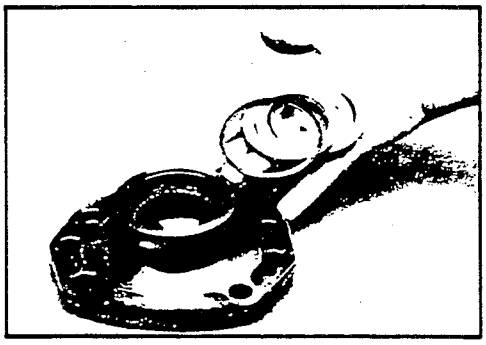


Figure 11-89. Assembling Washers and Seals.

40. Assemble retaining ring (46) into the ring groove in the side cover (figure 11-90).

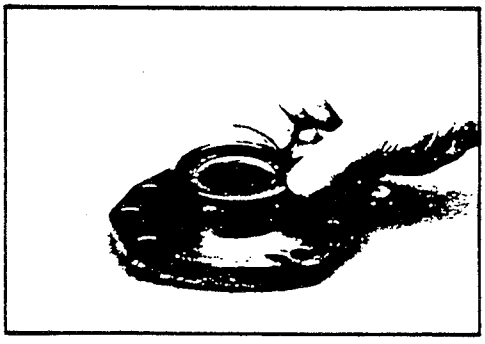


Figure 11-90. Installing Retaining Ring.

41. Apply a generous amount of clean grease to the short bearing area of the sector shaft (39), and insert the sector shaft into the side cover (42). Screw the adjusting screw into the side cover until it reaches solid height. Then, back out the adjusting screw one turn, so that the side cover rotates freely on the sector shaft (figure 11-91).

42. Assemble the jam nut (53) onto the adjusting screw (40) a few threads. Final adjustment will be made later.

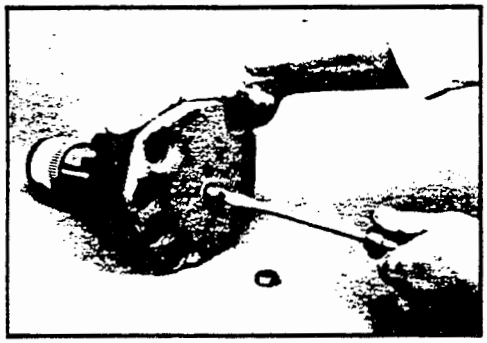


Figure 11-91. Setting Adjusting Screw.

43. Assemble the vent plug (47) into the hole provided on the side cover (42). Press the vent plug in flush with the side cover (figure 11-92).

WARNING: Do not weld or otherwise plug this hole in any permanent manner. This is a safety vent which functions only if the side cover seal fails. If the plug cannot vent, the steering gear may lock up or otherwise malfunction.

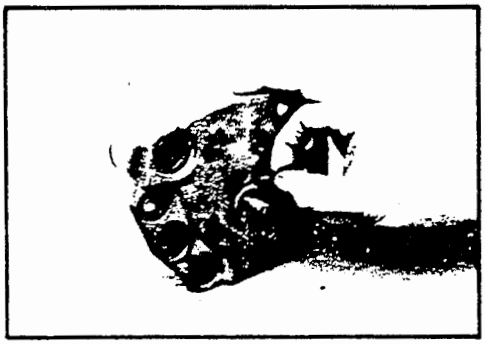


Figure 11-92. Installing Vent Plug.

44. Apply clean grease to the new side cover gasket (48) and assemble it onto the side cover (42). There must be enough grease to hold the gasket in place (figure 11-93).

There are four teeth on the rack piston (10) (figure 11-94).

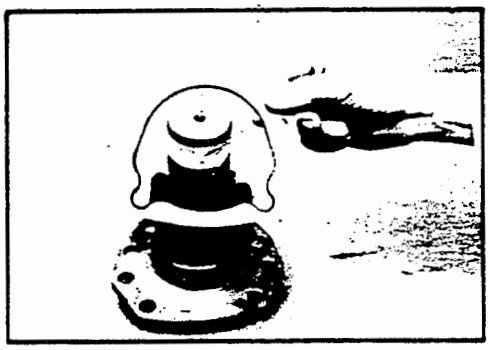


Figure 11-93. Side Cover Gasket.

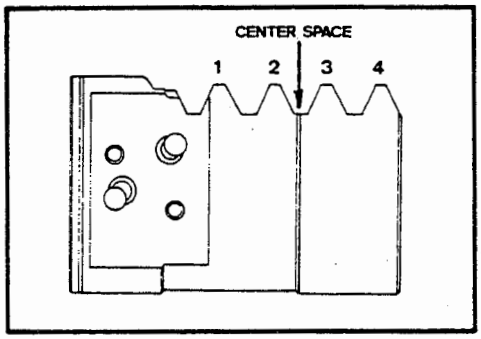


Figure 11-94. Rack Piston Teeth.

45. Position the tooth-space between the second and third teeth in the center of the sector shaft cavity (figure 11-95).

CAUTION: If the rack piston is not centered, the gear travel will be severely limited in one direction of travel, and significant internal damage to the steering gear can occur when the gear is operated.



Figure 11-95. Centering Gear Tooth Space.

46. Clean off any old tape on the sector shaft (39) serrations. Retape the serrations and bolt groove with one layer of tape. Assemble the sector shaft (39) side cover (42) assembly into the gear housing (1), with the center tooth of the sector shaft engaging the tooth space between the second and third teeth on the rack piston (figures 11-96 and 11-97).

CAUTION: As you place the sector shaft through the housing bearing (2), be careful not to dislodge any of the bearing rollers. Be careful also not to pinch the side cover gasket (48). Should the bearing rollers be dislodged, or the side cover gasket pinched, premature bearing and seal failure may occur, which could result in a loss of power steering assist.

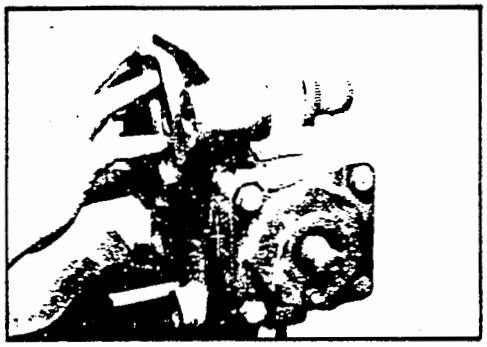


Figure 11-96. Installing Side Cover Assembly.

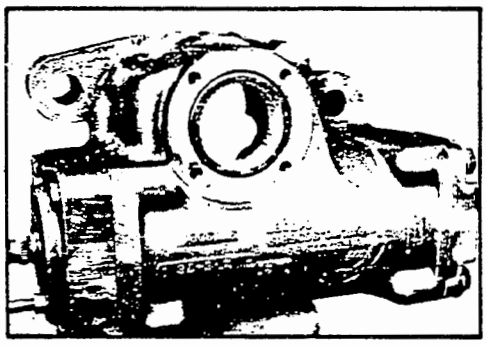


Figure 11-97. Bearing Rollers Installed.

47. Assemble the eight special ring head bolts (52) and tighten them to 150-170 ft. lbs. (203-230 Nm) torque.

48. Place the trunnion cover (49) on a bench to install the new seal package. Start with the Teflon backup washer (50).

49. Assemble the two-piece sector shaft seal (51) so that the words "oil side" are visible.

CAUTION: The words "oil side must be visible. If not, the seal will not function and a loss of power steering assist may occur.

50. Grease the new trunnion cover O-ring (31) and install it into the trunnion cover O-ring groove

51. Before installing the trunnion cover (49) and seal assembly onto the housing (1), visually inspect the housing bearing (24) to ensure that all bearing rollers are properly in place. Then install the trunnion cover (figure 11-98).



Figure 11-98. Installing Trunnion Cover.

52. Install a new dirt and water seal (34). Install four trunnion cover bolts (32) and tighten the bolts to 15-22 ft. lbs. (20-29 Nm) torque (figure 11-99).

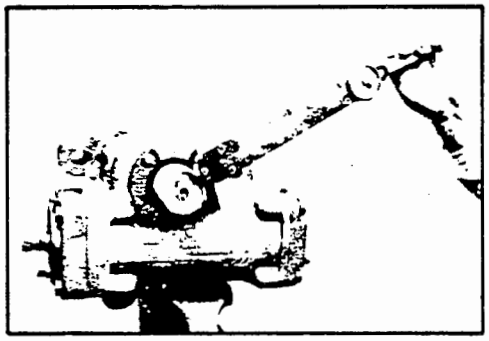


Figure 11-99. Tightening Trunnion Cover Bolts.

53. Apply clean grease to the input shaft seal assembly (35 & 36) and to the input shaft. Install the new two-piece input seal (35) flat side up and the steel backup washer (36), using the seal driving tool J28490. Install the retaining ring (38) (figures 11-100 and 11-101).

54. Pack the area around the input shaft with clean grease and install the dirt and water seal (37).

This completes assembly. Before installing gear onto coach, make the final adjustments as follows:

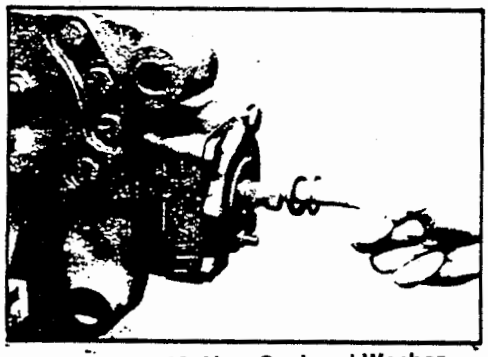


Figure 11-100. New Seal and Washer.

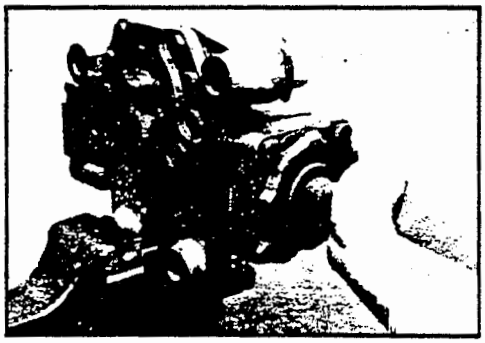


Figure 11-101. Use of Seal Driving Tool.

FINAL ADJUSTMENTS

1. Screw the worm shaft preload adjusting screw (27) finger tight until it contacts the worm shaft (5a).

2. Adjust the sector shaft adjusting screw (40) while rotating the input shaft 90 degrees each direction until the input shaft torque reaches 25-30 in. lbs. (2.825-3.39 Nm) (figure 11-102).

NOTE: Use a 12-point socket and an In. lb. (Nm) torque wrench to rotate the input shaft.

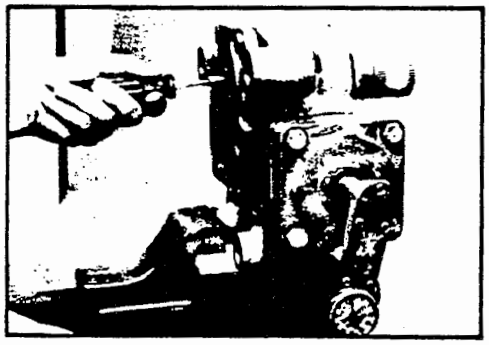


Figure 11-102. Shaft Adjusting Screw.

3. Center the steering gear by aligning the sector shaft timing mark halfway between two trunnion cover bolts. The timing mark will be perpendicular to the center line of the cylinder bore.

4. Back out the sector shaft adjusting screw (40) one turn and note the torque required to rotate the input shaft through 90 degrees each side of center.

5. Move the adjusting screw to provide a rise in torque of 2-4 in. lbs. (.226-.452 Nm) at this point within 45 degrees each side of center.

6. After tightening the jam nut (53) to 40-45 ft. lbs. (54.2-60.98 Nm), the torque now required to rotate the input shaft must not exceed 29 in. lbs. (3.28 Nm) at any point in the steering gear travel.

7. Tighten the worm shaft preload adjusting screw (27) to 60-70 in. lbs. (6.78-7.91 Nm) torque, making sure the jam nut (28) does not contact the end cover (26).

8. Tighten the jam nut to 70-80 ft. lbs. (94.85-108.4 Nm), making sure the adjusting screw does not move.

9. Confirm that the torque now required to rotate the input shaft through complete travel does not exceed 50 in. lbs. (5.65 Nm).

NOTE: 55 in. lbs. (6.215 Nm) is allowable if fluid is in the gear.

MC-9 MAINTENANCE MANUAL

INSTALLATION OF STEERING GEAR

1. Align steering gear housing with mounting holes in undercarriage frame. Install bolts with hard steel washers and tighten the ⅞" bolt to 475-525 ft. lbs. (644-712 Nm) torque. Tighten the ¾" bolts to 295-325 ft. lbs. (400-441 Nm) torque.

2. Install Pitman arm on gear output shaft with alignment marks aligned. Tighten Pitman arm nut to 310-320 ft. lbs. (420-434 Nm) torque.

3. Bleed air from power steering system, as detailed below.

4. Attach drag link to Pitman arm. Install end clamp bolt and tighten to 60-80 ft. lbs. (81-108 Nm) torque.

5. Connect steering shaft to steering gear actuating shaft. Install clamp bolt with washer and nut. Tighten to 25-30 ft. lbs. (34-41 Nm) torque.

6. Remove protective caps from power steering gear supply and return lines and connect the lines to the gear.

7. Connect height control valve link to mounting bracket. Raise coach to normal ride height and remove the spacers from the axle.

8. Check the fuel oil level in the hollow center axle. Replace any loss that occurred during power steering gear removal. The axle holds two quarts of fuel oil.

9. Fill the power steering reservoir to FULL mark on sight glass. Use oil specified in Lubrication, Section 10.

10. Bleed the hydraulic system as directed under Bleeding Air from System, below.

BLEEDING AIR FROM POWER STEERING SYSTEM

NOTE: This procedure is to be followed any time the hydraulic loop has been opened, depending on what area has been worked on. The time to bleed the system could be considerably less than for a total system purge.

1. Ensure all power steering connections have been made and are properly tightened.

2. Add fluid (10W-40 oil) to reservoir and fill until oil is to bottom of fill spout in reservoir cover.

3. Start engine, but do not operate at higher than idle rpm.

4. At the instant the engine starts, oil level will drop in the reservoir as oil fills the supply line to the power steering gear. Oil must be continually added to ensure pump inlet is not allowed to starve or run dry.

5. When oil level stabilizes within the reservoir, the oil level should be brought to the sight glass level.

6. With the engine at idle speed, the steering wheel should be turned lock to lock at least six times. When all air is removed from the system, air bubbles will no longer surface through the oil in the reservoir. While air bubbles are still surfacing, it indicates that the system is not completely bled. In this case the steering wheel must continue to be cycled lock to lock and the oil level must be constantly monitored and oil replenished.

7. With the system fully bled, fill the reservoir to specified levels. Replace cap on reservoir.

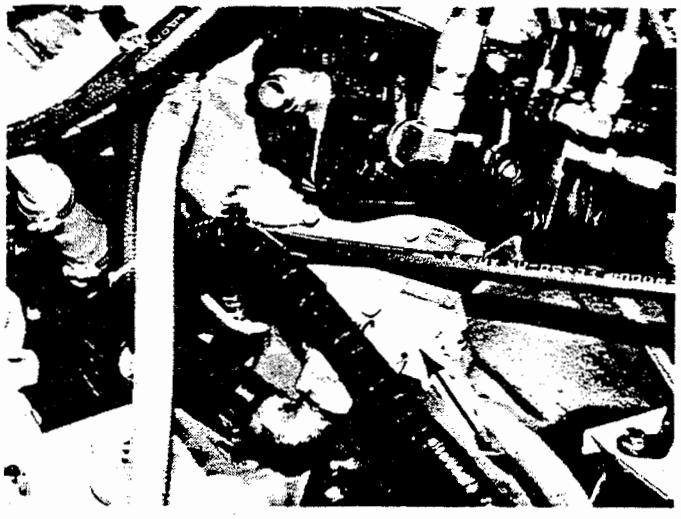


Figure 11-103. Power Steering Pump - Installed.

MC-9 MAINTENANCE MANUAL

POWER STEERING PUMP

The power steering pump is gear driven and mounted on the flywheel housing. Refer to figure 11-103. It is a balanced vane pump with a constant delivery per revolution and a capacity of 4 gallons (15.2 liters) per minute at idle speed. The maximum pump relief pressure is 1,500 psi (10,350 kPa).

REMOVAL AND INSTALLATION

The pump is accessible through the right hand engine compartment door. It is removed by disconnecting the outlet hose and removing the inlet at the rubber hose connecting pump inlet to reservoir outlet. Then remove the two mounting bolts. The mounting flange gasket should be replaced whenever the pump is removed. To install the pump, reverse the above procedure.

DISASSEMBLY

During the disassembly, special attention should be given to identification of parts for proper reassembly. (See figure 11-104).

1. Using a suitable cleaning solvent, thoroughly clean the exterior of the power steering pump to prevent entry of dirt or other foreign matter into the pump during overhaul procedures.
2. Remove the three manifold capscrews (24) and washers (25).
3. Remove manifold (26); remove and discard manifold gasket (10).
4. Remove cover mounting capscrews (22) and separate the cover from the pump body (11).
5. Remove pressure plate spring (18) and pressure plate (17).
6. Remove pump ring (15) locating pins (16), rotor (13) vanes (14) and the two O-rings (7 & 8).

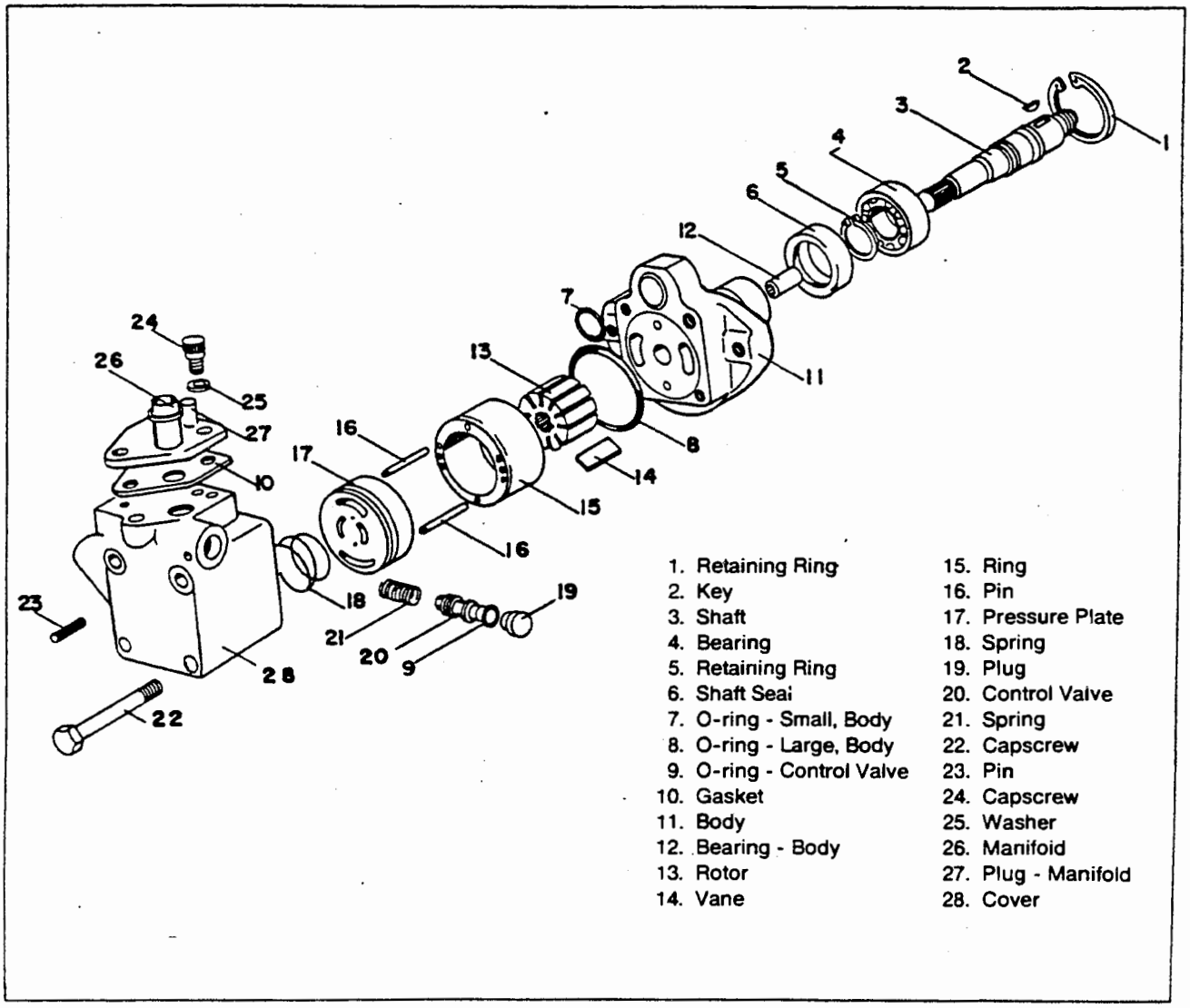


Figure 11-104. Power Steering Pump.

7. Mount the cover in a vise. Drive out the retaining pin (23) with a suitable punch.

8. Protect the control valve plug (19) and subassembly against falling from the bore. Work the plug (19), control valve (20) and spring (21) from the bore.

NOTE: Access to the control valve plug and control valve subassembly may be gained through the large chamfered hole which leads to the control valve bore from inside the cover.

9. Remove outer retaining ring (1) from the pump body (11).

10. Support the shaft end (3) of the pump body (11) in a 2 inch (50.8 mm) straight pipe coupling, and using an arbor press, remove shaft (3). The shaft assembly should drop through a slot in the press table so that the shaft will not be damaged.

11. Remove inner retaining ring (5) and ball bearing (4) from shaft (3).

12. Press shaft seal (6) from the pump body.

INSPECTION AND REPAIR

1. Wash all parts, except seals, in clean mineral spirits and lay them aside for inspection. Replace all old seals and O-rings at reassembly.

2. Inspect surfaces of ring (15) rotor (13), vanes (14), pressure plate (17) and body (11) which are subject to wear. Light scoring may be removed from the faces of the body or wear plate with crocus cloth (by placing the cloth on a flat surface), medium India stone or by lapping.

3. Check edges of vanes (14) for wear. Vanes must not have excessive play in slots or burrs on edges. Replace if necessary.

4. Check each rotor slot for sticky vanes or wear. Vanes should drop into rotor slots by their own weight when both slot and vane are dry.

5. Insert the control valve (20) in its bore in pump cover. There should be no binding.

6. Check the valve (20) and bore for excessive wear and scoring. Replace if necessary.

7. Wash bearing (4) thoroughly. Inspect and replace if worn or damaged.

8. Replace the shaft seal (6) at each overhaul to prevent oil leakage. Check the drive shaft oil seal diameter for wear and scoring. Do not install a new seal on a shaft which is worn or damaged at the oil seal diameter. Replace the shaft (3) if worn.

9. Stone and polish the sharp edges on the shaft to prevent damage to the seal (6).

10. Stone all mating surfaces of body and cover with a medium India stone to remove all burrs and sharp edges. Rewash all parts after stoning.

REASSEMBLY

NOTE: Immerse all parts in clean 10W-40 engine oil to facilitate reassembly.

1. Starting with the shaft end, press the inner needle bearing (12) in the pump body (11) using an arbor press.

2. Assemble the retaining ring (5) on the shoulder portion of the shaft (3) and install the shaft in the pump body (11).

3. Press the outer bearing onto the shaft. The edge of the bearing must be 1/64" (.39 mm) below the shaft seal shoulder when assembled. This provides for shaft end play of .010-.015" (.254-.381 mm).

NOTE: Tools for installing bearings can be made from round stock with an outside diameter slightly smaller than that of the bearing and the inside diameter slightly larger than the shaft diameter. Do not score or damage the shaft (3) during this operation.

4. Position the shaft seal (6) on the shaft end of the body (11), being careful not to damage the seal.

5. Using the special tool mentioned above, press seal (6) in until it locates against the shoulder in the pump body (11). This shoulder acts as a positive stop for the seal. Do not overpress as this will result in damage to the seal.

6. Install the locating pins (16) in the pump body (11).

7. Install the ring (15) over the pins (16) according to the correct direction of rotation.

8. Install the rotor (13) with the chamfered edge of the splined hole "in" toward the pump body (11).

9. Install the vanes (14) with their radius edge toward the inner ring contour.

10. Oil the cartridge with clean engine oil and install the pressure plate (17).

11. Install the presure plate spring (18) and cover (28).

12. Tighten cover screws to 25-30 ft. lbs. (34-40 Nm) torque.

13. Install the pressure compensating spring (21) into the control valve bore.

14. Insert the valve assembly (20) with the hex toward the spring (21).

15. Install plug (19) with the O-ring into the bore and hold it in position while driving in a new retaining pin (23).

16. Install the O-rings (7 & 8) in the pump body (11) and secure the manifold (26) to the pump cover (28) with three screws (24). The copper washers (25) are used on the three screws (24) where the tapped hole enters the oil passage.

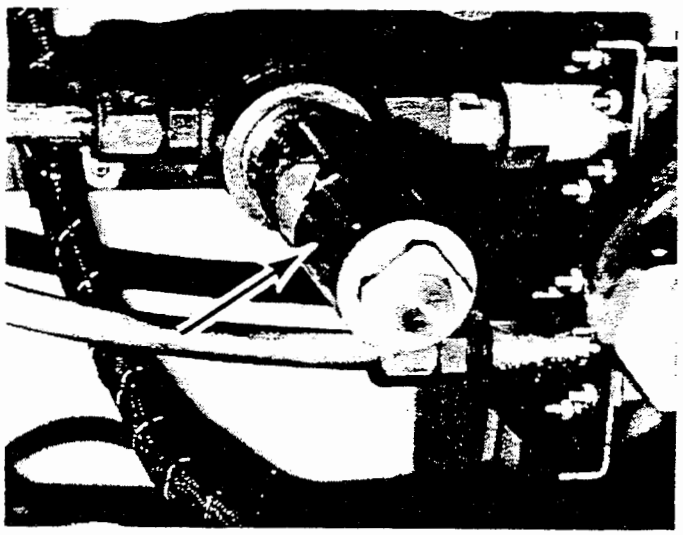


Figure 11-105. Power Steering Filter - Installed.

MC-9 MAINTENANCE MANUAL

POWER STEERING PRESSURE FILTER

The power steering filter is located in the upper right side of the engine compartment (figure 11-105). This is a pressure line filter. At regular intervals or 50,000 miles (80,000 km), the filter should be removed and replaced.

NOTE: This filter should be replaced in conjunction with servicing and replacing the reservoir filter element. The power steering system should be bled at this time.

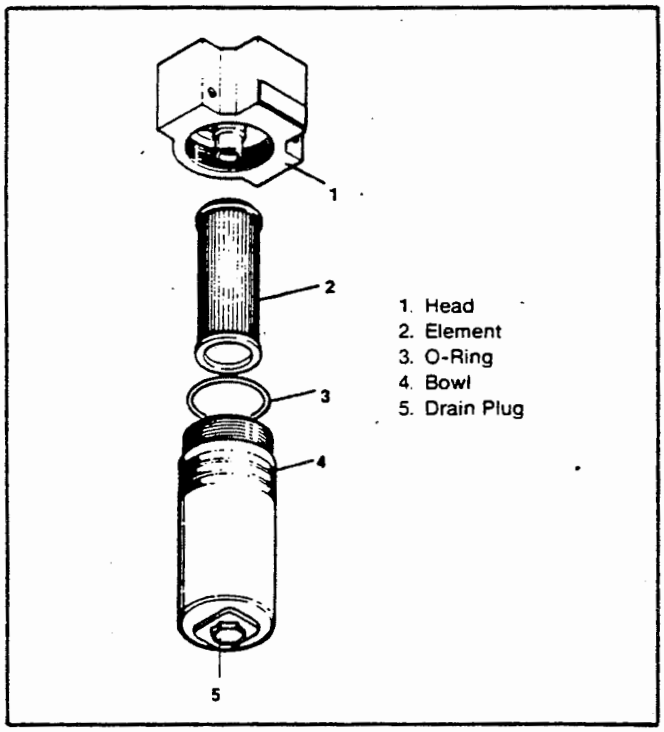


Figure 11-106. Power Steering Filter.

1. Shut down the system and release all pressure in filter line.
2. Unscrew the bowl and lower it vertically to clear the element assembly. See figure 11-106.
3. Remove the element from the filter head by pulling it from the element locator. Discard and replace with new element.
4. Install new element by pushing it onto the locator.
5. It is recommended that the bowl O-ring be replaced before refitting to the housing.

POWER STEERING RESERVOIR AND FILTER

A power steering reservoir, filter and sight gauge (figure 11-107) are located in the upper right hand side of engine compartment. The filter element should be serviced at the same intervals as replacing the power steering pressure filter element, approximately 50,000 miles (80,000 km), depending on operating conditions. When replacing the element refer to figure 11-108.

NOTE: After new element and gaskets are installed, install cover and bolt assembly. Check for leaks after operating system.

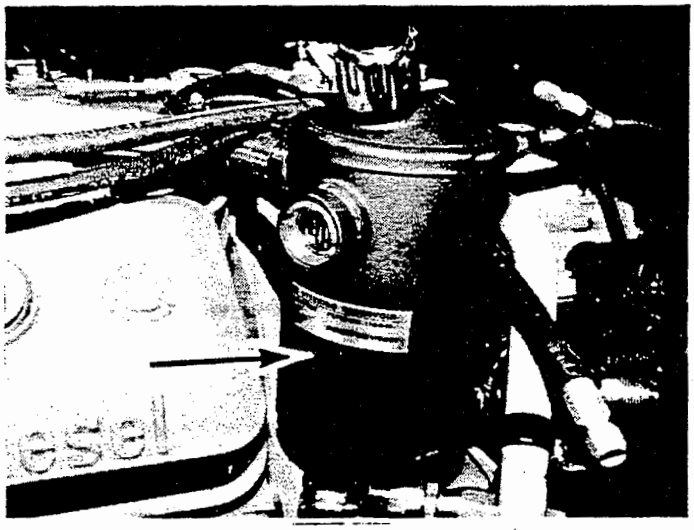
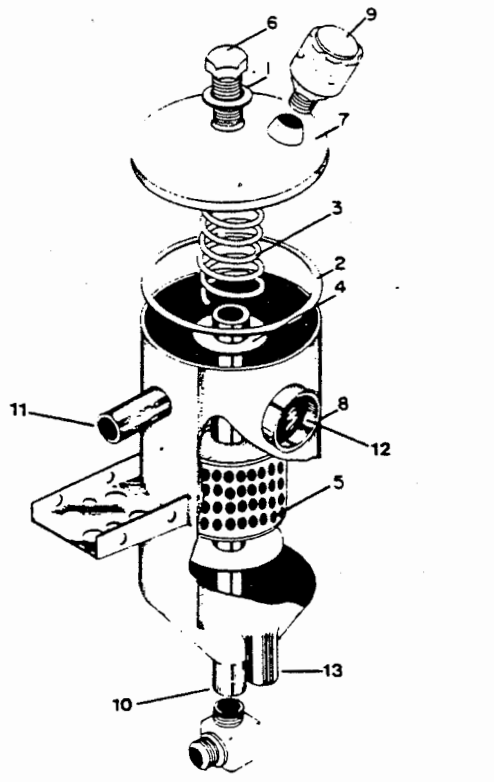


Figure 11-107. Power Steering Reservoir and Filter.



1. Cover Bolt Gasket
2. Cover Gasket
3. Cartridge Retaining Spring
4. Cartridge Support Washer
5. Filter Cartridge
6. Cover Bolt
7. Cover
8. Shell
9. Breather Cap
10. Reservoir Inlet
11. Filler Inlet
12. Sight Glass
13. Outlet

Figure 11-108. Reservoir Filter Parts.

FILLING POWER STEERING SYSTEM

NOTE: For steps 1 and 2, do not turn the steering wheel. Otherwise, air will enter the system.

1. Fill the reservoir nearly full. See figures 11-107 and 11-109. Crank the engine for 10 seconds without allowing it to start. If the engine does start, shut it off immediately.
2. Check and refill the reservoir as necessary. Perform this procedure three times, each time checking and refilling the reservoir.

CAUTION: Do not allow the fluid to drop significantly or run out of the system. This will allow air into the system.

3. Start the engine and let it idle for two minutes, shut the engine off and check the fluid level in the reservoir.
4. Start the engine. Steer the coach from full left to full right several times.
5. Add fluid to reservoir until it reaches the halfway point in the sight glass.

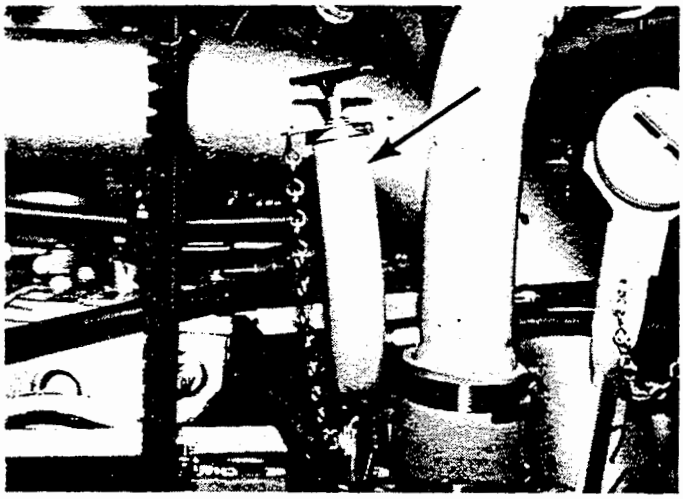


Figure 11-109. Power Steering Reservoir Fill.

SAFETY INSPECTION

It is the manufacturer's recommendation that at major inspections or every 300,000 miles (480,000 km), depending on operating conditions, the front end steering components be Magnaflux or Magnaglo inspected. This also applies when purchasing a used coach.

This recommendation is due to various hazards while coach is in service; extremely rough road surfaces, curbing of tires, or accidents. In some instances at disassembly of steering components, damage may also be caused due to heavy hammering or application of heat.

Important steering parts to be Magnaflux or Magnaglo inspected are the following:

Pitman Arm
Drag Link Ends
All Ball Studs
Cross Tube End and Steering Arms
Main Steering Arm
Lever Shaft (Sector)
Worm Shaft
Axle Spindles

Other components being visually inspected that may be doubtful should also be included in the Magnaflux or Magnaglo inspection.

CAUTION: Do not utilize any methods for repair on steering components such as welding, metal plating, etc. Replace with genuine new parts.

DRAG LINK

The steering drag link assembly is a three-piece type. It consists of a long tube and two stud ends, one of which joins to the steering Pitman arm and one that joins to the main steering arm at the front axle. Clamps at both ends are used for positive adjustment and locking.

REMOVAL AND INSPECTION

1. Refer to figure 11-110. Remove the cotter pins and castle nuts from the drag link ends.
2. Remove the drag link.
3. Loosen the clamps and unscrew the ends from the drag link rod.
4. Carefully inspect all parts and replace any that are worn or damaged. Magnaflux or Magnaglo inspection procedure is recommended.
5. Clean components with a suitable cleaning fluid.
6. Lubricate all studs and tapers. Reassemble them in reverse order of disassembly. Tighten clamp bolts and the castle nuts at each end of drag link to torques shown in the torque specification illustration at the end of this section.

NOTE: When installing the clamps on the drag link ends, the open side of the clamps must be turned downward and the clamp bolts inserted as shown in figure 11-117.

INSPECTION PROCEDURE FOR DRAG LINK/PITMAN ARM CONNECTION

1. Remove the cotter pin and loosen the castellated nut fastening the steering drag link and back off three full turns.
2. Check for looseness in the tapered connection by applying hand pressure against the drag link in a direction away from the pitman arm. DO NOT hit the ball stud or drag link with a hammer, pry bar or other object in an attempt to unseat the taper. If the taper connection is not properly seated, hand pressure alone will be sufficient to separate the parts.
3. If the tapered connection remains together, reinstall the castellated nut and torque to 230-260 ft. lbs. (311-353 Nm). Install a NEW cotter pin (⅛"×1½"). Do not back off the nut to insert the cotter pin into the ball stud cotter hole. If necessary, tighten the nut further to the next closest slot, to install the cotter pin.

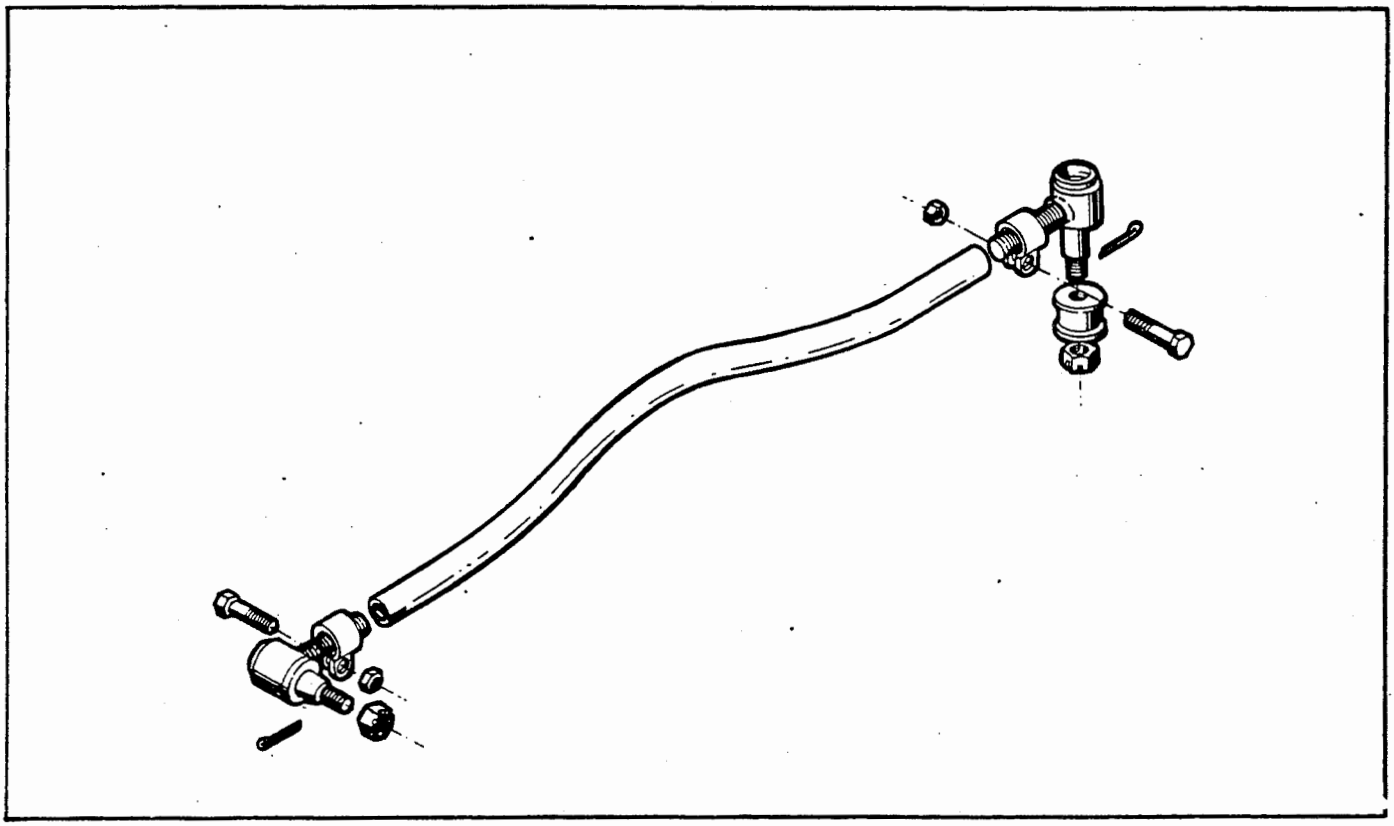


Figure 11-110. Drag Link.

MC-9 MAINTENANCE MANUAL

TROUBLESHOOTING

TROUBLE	REMEDY
PUMP NOT DELIVERING FLUID Drive in wrong direction of rotation. Pump driveshaft disengaged or sheared.	1. Check direction of pump shaft rotation. 2. Remove pump; determine damage to cartridge parts (see disassembly instructions); replace sheared shaft and damaged parts. Refer to Power Steering Pump.
Flow control valve stuck open.	1. Disassemble pump and wash control valve in a clean solvent. 2. Return valve to its bore and slide it back and forth. No stickiness in movement should occur. If a gritty feeling is noted on the valve O.D., it may be polished with crocus cloth. Avoid removal of excess material or round off of valve edges during this operation. Do not attempt to polish the valve bore. 3. Wash all parts before reassembly of pump. 4. Flush entire system thoroughly and fill with clean oil as recommended.
Vane(s) stuck in rotor slots.	1. Disassemble pump, examine rotor slots for dirt, grime or small metal chips. 2. Clean rotor and vanes in a good grade solvent (mineral spirits or kerosene); reassemble parts and check for free vane movement.
Fluid viscosity too heavy to prime. Pump intake partially blocked.	1. Use fluid of the viscosity as recommended. 2. Drain system completely; flush to clear pump passages. 3. Flush and refill system with clean oil as recommended.
Air vent for oil reservoir clogged, or dirty strainer.	1. Remove filler cap and clean air vent slot. 2. Check filter or strainer in tank for clogged condition. 3. Drain, flush and add clean oil to system if strainer was clogged.
PUMP MAKING NOISE Restricted or partially clogged intake line or clogged filter.	Pump must receive intake oil freely or cavitation will result. 1. Drain system, and clean intake line and strainers. 2. Add new oil and strain by recommended procedures.
Air leak at pump intake piping joints or pump shaft seal.	1. Test by pouring oil on joints and around drive shaft. 2. Listen for change in operation. 3. Tighten joints affected and replace pump drive shaft seal according to service instructions; refer to Power Steering Pump.
Coupling misalignment.	Realign and replace oil seal and bearings if damaged by shaft misalignment.
Reservoir or manifold seal leakage. Leakage between manifold or reservoir at replenishing hole due to O-ring damage.	1. The reservoir inlet-tube-to-pump-cover O-ring should be carefully examined for damage such as cuts, nicks or dirt. 2. Replace as necessary. Refer to Power Steering Reservoir and Filter.
HARD STEERING EITHER WHILE PARKING OR EXISTING ALL THE TIME. Insufficient pump pressure.	1. Check pump pressure with gauge. 2. If sufficient, check for cause — sticky relief valve in pump or flow control.
Defective pump.	Repair or replace defective parts.
Sticky control valve in pump or flow control which prevents pressure build-up.	Replace valve. (May require total pump replacement.) Refer to Power Steering Pump.
"LUMPY" FEELING (SPOTS OF HARD STEERING) Delayed power application.	Check and eliminate excessive free play in steering linkage.

MC-9 MAINTENANCE MANUAL

TROUBLE	REMEDY
Air in steering system.	Bleed system as per previous instruction.
Loose joints or linkage.	Tighten where necessary.
Insufficient oil flow.	1. Check for damaged hoses, weak or sticking valve spring, or worn pump parts. 2. Repair or replace as necessary.
Low oil supply.	Check level and refill.
HARD STEERING ACCOMPANIED BY ABNORMAL NOISE Air in system.	Bleed as per instructions in Bleeding Air from Power Steering System.
HARD STEERING ACCOMPANIED BY ABNORMAL NOISE Pump malfunction.	See Power Steering Pump, Inspection and Repair.
Low oil supply	See Power Steering Pump, Inspection and Repair.
NO RECOVERY FROM TURN TO STRAIGHT AHEAD Insufficient caster.	Increase caster; refer to Front Axle Specifications Chart, Section 1.
Tight ball socket connections and other linkage connections.	Loosen connections but keep them snug.
Tight front axle spindles.	Adjust linkage; refer to Section 1.
Spool in steering gear valve sticking. (Prevents centering of valve.)	1. Disassemble valve and inspect for sticking. 2. Clean. 3. Reassemble valve or replace and reinstall on gear. See HFB70 Integral Steering Gear.
Tire pressure low.	Check pressure and inflate tires.
Front end out of alignment.	Align front end; refer to Section 1.
Steering column binding.	Eliminate bind; refer to Steering Column.
Pump flow insufficient.	Check pump pressure with gauge. If insufficient check for cause and repair pump and/or lines; refer to Power Steering Pump.
Steering gear improperly adjusted.	Adjust to specifications.
SHIMMY Loose ball socket connections or other linkage connections.	Tighten; see Section 1.
Wheels out of balance.	Balance.
Wheel bearings improperly adjusted or worn.	Check bearings; replace if necessary.
Excessive caster.	Correct and have front alignment checked to specifications.
EXTERNAL OIL LEAKAGE	Finding location of leak may be difficult, as oil may "run" away from leak point on the gear of chassis. 1. Check all fittings, clamps, hoses, and pump. 2. Repair or replace any possible causes of leakage.

MC-9 MAINTENANCE MANUAL

TROUBLE	REMEDY
EXCESSIVE PUMP PRESSURE WITH STEERING GEAR IN NEUTRAL POSITION Kink in oil return line.	Relocate line to remove kink.
OTHER CAUSES OF HARD STEERING Caster and camber degree incorrect.	Correct to specification; see Front End Alignment Chart, Section 1.
Air in system.	Bleed system and check for source of air.
LOST MOTION OR LASH AT STEERING WHEEL Steering wheel loose on shaft.	Tighten to specifications.
Loose connections between gear and steering column.	Tighten connections; refer to Steering Column.
Steering gear loose on frame.	Tighten.
Pitman arm loose on sector shaft.	Tighten.
Components in steering linkage loose or worn.	Tighten or replace where necessary.
Steering gear improperly adjusted.	Adjust.
OVERHEATING OF STEERING GEAR Undersize replacement hose or line.	Replace with correct size hose or line.
Restricted hose or line due to kink or severe bend.	Relocate line or hose to remove kink.
Restricted recentering of valve due to column binding or side loading of input shaft. **CAUTION: If the hydraulic system fluid becomes overheated, it can cause the seals in the steering gear to shrink, harden, or crack and lose their sealing ability.**	Inspect and repair gear to correct; refer to Steering Gear.
EXTERNAL OIL LEAKAGE Rubber relief (vent) plug leaking at side cover indicates failure of sector shaft oil seal in side cover.	Replace oil seal.
OVERHEATING OF STEERING GEAR Poppets not properly adjusted.	Adjust to specifications.

MC-9 MAINTENANCE MANUAL

SPECIFICATIONS

POWER STEERING GEAR INTEGRAL STEERING

Manufacturer	Ross Gear
Model	HFB70054
Ratio	23.3:1

POWER STEERING GEAR PUMP

Manufacturer	Vickers
Model	VTM-42-40-55-15-ME-R1-14-S4
Type	Vane
Rotation	Clockwise (viewed from shaft end)
Location	Mounted on Flywheel Housing
Maximum Output Pressure	1,500 psi (10,350 kPa)

ROTOR

Width	0.7695-0.7693" (19.5453-19.5402 mm)
Outside Diameter	1.598-1.593" (40.589-40.262 mm)
No. Vane Slots	10
Vane Slot Width	0.0785-0.0780" (1.9939-1.9812 mm)

ROTOR VANES

Quantity	10
Thickness	0.0775-0.0770" (1.9685-1.9558 mm)
Width	0.343" (8.712 mm)
Length	0.7692-0.7689" (19.5377-19.53 mm)

RELIEF SPRING

Free Length	2.5468" (64.6887 mm)
Compressed Length	Under 6.25 lbs. - 1.2968" (2.84 kg-32.9387 mm)
	Under 8.2 lbs. - 0.9062" (3.72 kg-23.0175 mm)
Rate	5 lbs. (2.27 kg) per inch (25.4 mm)

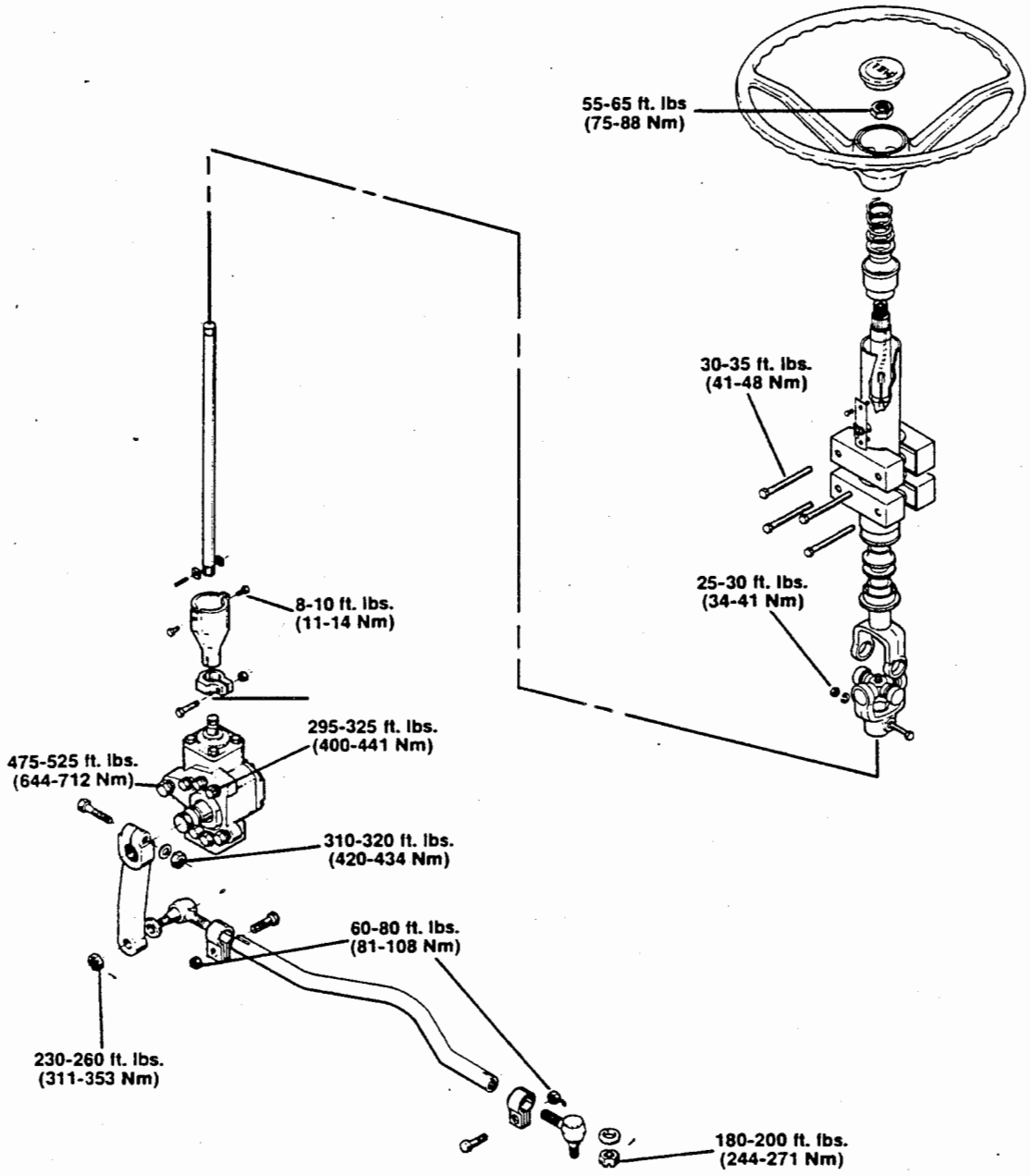
POWER STEERING RESERVOIR

Manufacturer	Walker Deluxe
Model	326497
Location	Mounted on Engine

POWER STEERING FILTER

Manufacturer	Parker
Model	15P-1-40W-14190
Location	At Front of Engine Compartment

MC-9 MAINTENANCE MANUAL



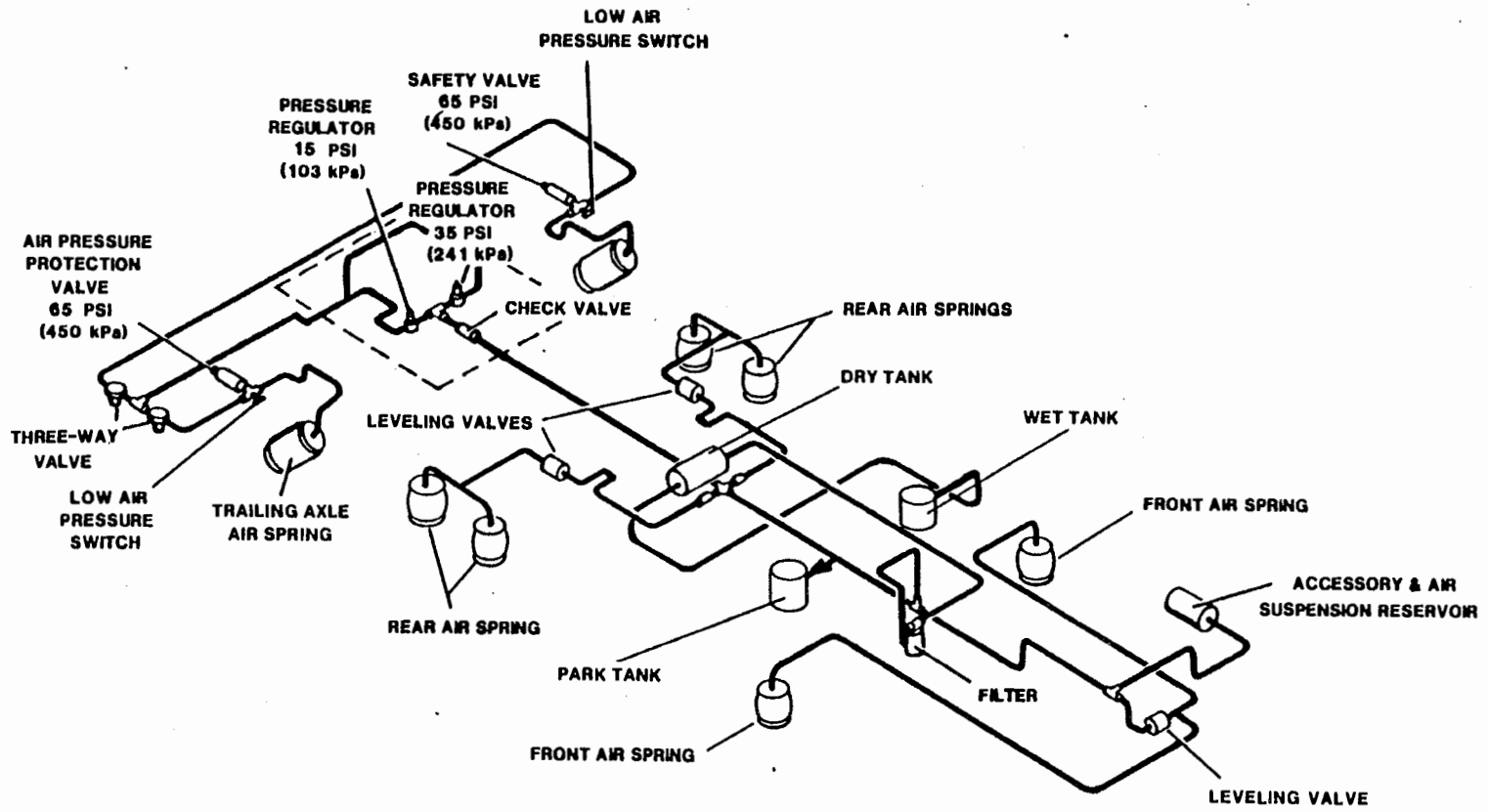
Torques at Steering System Connections

Date 1-1-89

MC-9 MAINTENANCE MANUAL

SECTION 12
SUSPENSION

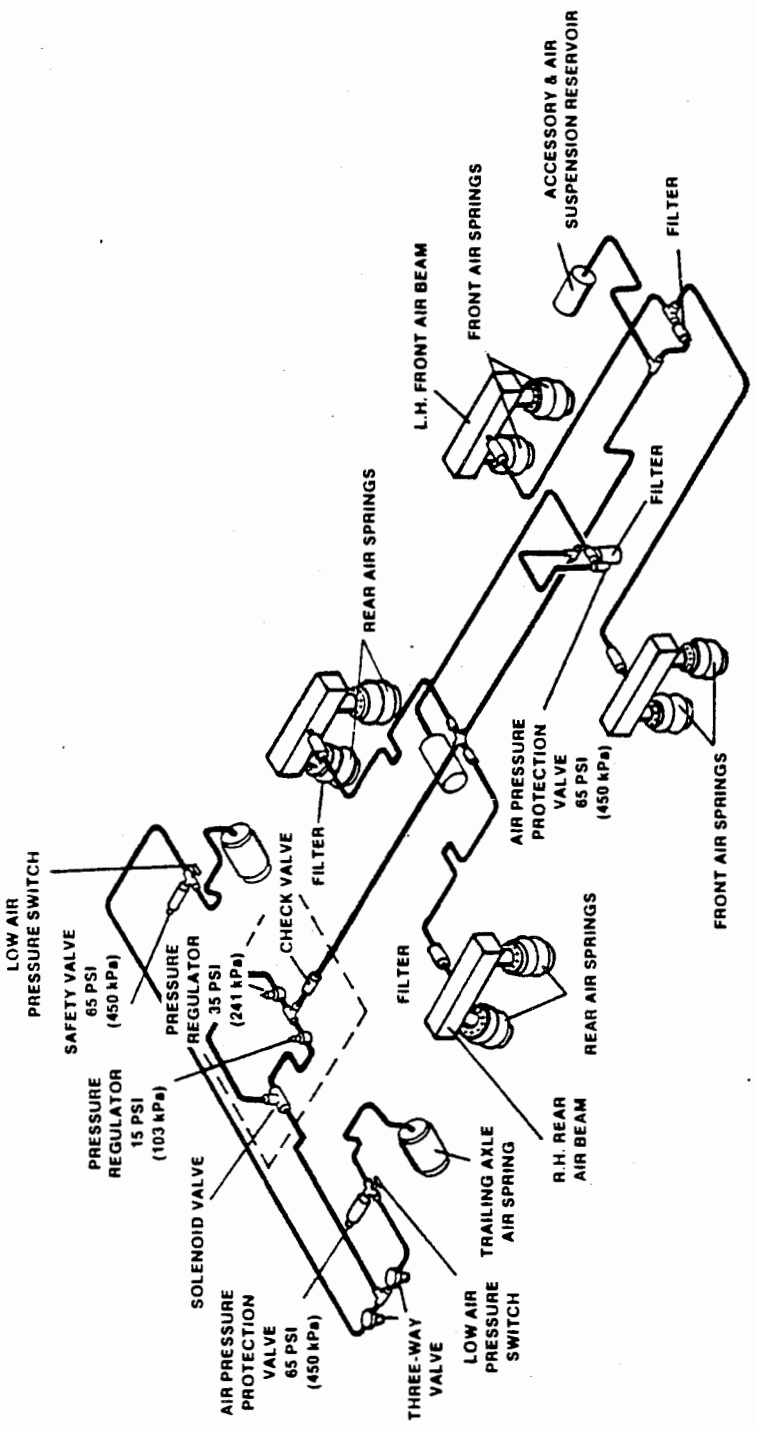
SUBJECT	PAGE
Air Springs	12-4
Filters	12-13
Height Control Valves	12-5
Pressure Protection Valve	12-15
Radius Rods	12-4
Service Tools	12-22
Shock Absorbers	12-12
Specifications	12-21
Suspension	12-3
Torques	12-17
Trailing Axle Unloading System	12-3
Service Bulletin Page	



AIR SUSPENSION COMPONENT LOCATION
(Effective with Unit 41089)

Figure 12-1A. Air Suspension Component Locations.
(Effective with Unit 41089)

MC-9 MAINTENANCE MANUAL



AIR SUSPENSION COMPONENT LOCATION
(Effective prior to Unit 41089)

Figure 12-1B. Air Suspension Component Locations.
(Effective prior to Unit 41089)

MC-9 MAINTENANCE MANUAL

SUSPENSION

DESCRIPTION

The coach rides on an air suspension system. Air springs (bellows) are installed above both the front and rear axles. They are fastened between the axle support strucures and the bogies. Air is supplied to the air springs from the coach air reservoirs.

Prior to unit 41089, the air reservoirs are in the bogie air beams (see figure 12-1A). Effective with that unit, air is stored in air tanks (see figure 12-1B).

Other suspension components are height control valves, radius rods and shock absorbers. The system is entirely automatic in operation and is designed to maintain a constant vehicle height regardless of load. A pressure regulating valve maintains constant pressure in the air springs and uniform loading of the rear trailing wheels regardless of total vehicle load. Refer to Section 4, Brakes and Air System, for regulating valve pressure setting.

The air springs are made from a special compound rubber molded to the proper contour and dimensions. The entire vertical load of the coach is taken by these air springs. See figures 12-1A and 12-1B.

Radius rods are used to hold the axles in the proper transverse and longitudinal position. Four radius rods are used at the rear axle and five at the front axle. These rods transmit both braking and driving forces from the axles to the coach body.

Delay-type height control valves increase or decrease the air pressure as required. Two height control valves are located at the rear axle, and one at the front axle. The valves are mounted on the coach body and are connected to the axles by rubber-bushed links. Because of the delay mechanism in each height control valve, the valves respond only to sustained variations in the height of the axles in relationship to the coach body. Thus no change in air pressure takes place during normal driving. However, the valves automatically regulate air pressure to compensate for changes in the load carried by the coach, or due to changes in the location of the coach load.

Double-acting shock absorbers are used to enhance ride characteristics. Two shock absorbers are used at the front axle, four at the rear and two at the rear trailing wheels.

An auxiliary air system is provided to supply compressed air for the operation of the system. Compressed air from the main system is fed to an auxiliary tank.

MAINTENANCE

The suspension system requires periodic lubrication only at the rear trailing axle trunnions. Refer to Lubrication (Section 10) of this manual. Routine maintenance should also include visual inspection procedures and occasional tests to determine that the correct coach body height is maintained. The suspension air filter should also be replaced periodically.

To remove axles, refer to Section 1, Front Axle, and to Section 2, Rear Axle.

NOTE: When installing major components of the suspension system, refer to the torque recommendations shown in the figures at the end of this section.

TRAILING AXLE UNLOADING SYSTEM - OPTIONAL

A switch mounted on the switch panel will allow the driver to partially unload the trailing wheels to add weight to the drive wheels on icy conditions (figure 12-2).

A buzzer and a low air tell-tale light will remind the driver to return the system to normal as soon as conditions permit. The trailing axle bellow air pressure is controlled from 35 psi to 15 psi (241 kPa to 104 kPa) in the unloaded position. This will increase the load on the drive wheels by approximately 2,000 lbs. (907 kg). See figures 12-3 and 12-4.

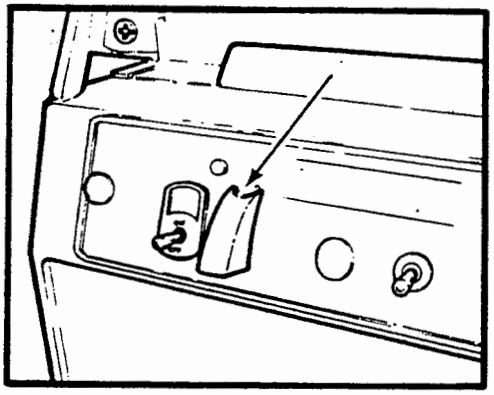


Figure 12-2. Unloading Switch on Instrument Panel.

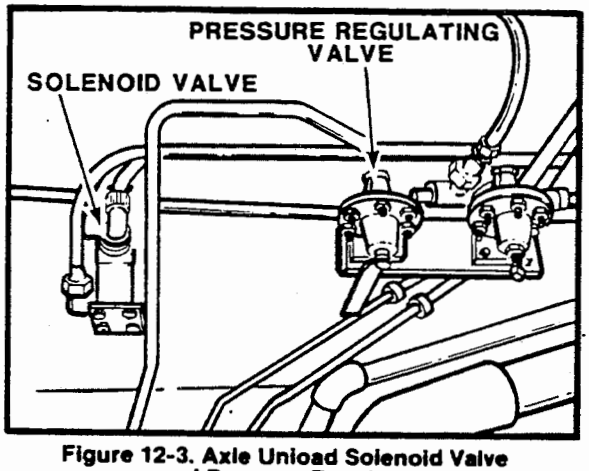


Figure 12-3. Axle Unload Solenoid Valve and Pressure Regulator.

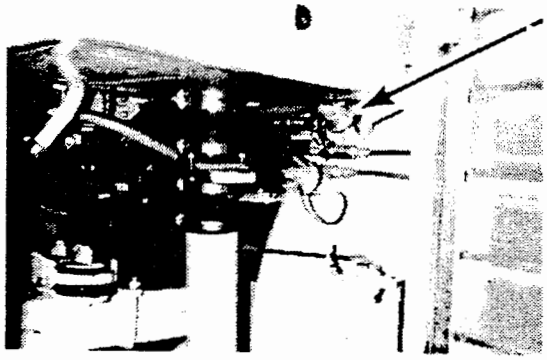


Figure 12-4. Trailing Axle Low Air Pressure Switch.

MC-9 MAINTENANCE MANUAL

AIR SPRINGS

Effective with unit 41089, the air springs are all of the rolling lobe (involute) type. The spring is made of molded rubber and consists of an outer section and a smaller inner, or piston, section which moves vertically.

Prior to unit 41089 the air springs used at the front and rear driving axles are of the double-convolution type, having beads reinforced at top and bottom with wire. Bead rings are specially formed and use special bolts. The surfaces of the bead ring and bolts are so designed as to prevent any chafing of the bellows. A girdle ring is molded in the center section of the bellows for reinforcement. The trailing axle air springs on the earlier suspension system are the rolling lobe style just as in the later system.

1. Raise and block the coach body as outlined under Front Axle Removal, Section 2.
2. Disconnect height control valve links and pull down on valve arm to exhaust air from the air spring.
3. On the front suspension, after air is exhausted, remove the air line to the air spring.
4. Remove nuts and washers from studs at top of air spring.
5. Remove the mounting bolts from the air spring mounting plate to the bottom of the air spring. The air spring may then be removed from coach.
6. On the rear suspension, after air is exhausted, remove the line to the air spring.
7. Remove the nuts and washers at top of the air spring.
8. Remove bolt from bottom and remove air spring.

Reverse procedure to replace air spring.

RADIUS RODS

The following instructions apply to radius rods used at the front and the rear driving axles.

Radius rods are mounted at both ends by means of bushings. The condition of these bushings should be checked periodically and any defective parts replaced. Radius rods should be checked for distortion and cracks. The Magnaflux process is recommended for detecting cracks in the radius rods. New bushings should be used when rods are replaced.

To remove radius rods, follow this procedure:

1. Flatten attaching nut locking plate and remove nuts.
2. Remove radius rod end plates from anchor pins.
3. Withdraw radius rod.

Installation of the radius rods is the reverse of removal. Apply Never-Seize or equivalent lubricant to the bushing inner race and radius rod pin.

It is extremely important upon reconnection of the rods that the proper clearance height between the axle and body is maintained; otherwise, the rubber bushings in radius rod ends will become preloaded, shortening the life of these parts. Refer to figures 12-5 and 12-6.

CAUTION: When reinstalling radius rods, make sure that the rod is centered on the bushing before tightening retaining nuts.

The radius rod should be held in a centered position with a pry bar against the coach body or axle while the stud nuts are tightened. See specifications at end of section for proper torque.

It is strongly recommended that periodic checks, depending upon operation conditions, be made on all radius rods and bushings. Due to the difficulty in checking the radius rod bushings at the anchor pin above the rear axle, they tend to be overlooked. Therefore, special emphasis should be placed on the checking of this area. If all worn bushings are not replaced, excessive wear to suspension components and tires will result.

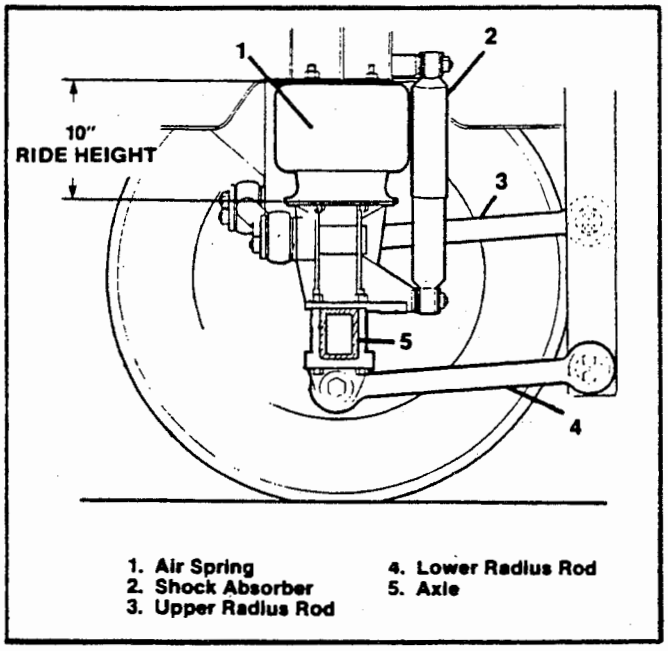


Figure 12-5A. Front Suspension Effective With Unit 41089.

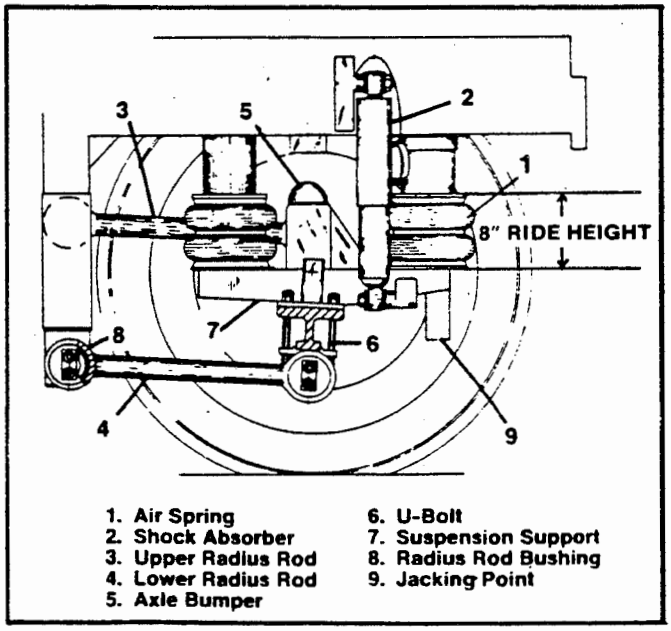
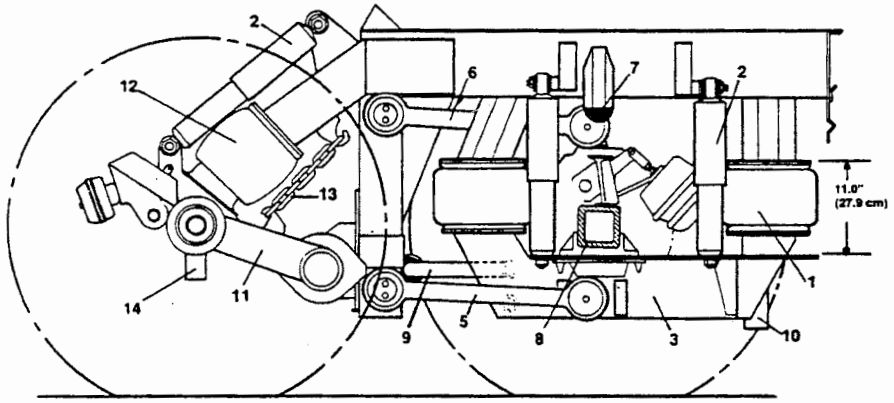


Figure 12-5B. Front Suspension Effective Prior to Unit 41089.

MC-9 MAINTENANCE MANUAL



1. Air Spring
2. Shock Absorbers
3. Suspension Support
4. Lower Radius Rod
5. Upper Radius Rod
6. Axle Bumper
7. Axle
8. Anti-Sway Bar
9. Jacking Point
10. Trailing Axle Arm
11. Air Spring
12. Hold-Up Chain
13. Jacking Point

Figure 12-6A. Rear Suspension Effective With Unit 41089.

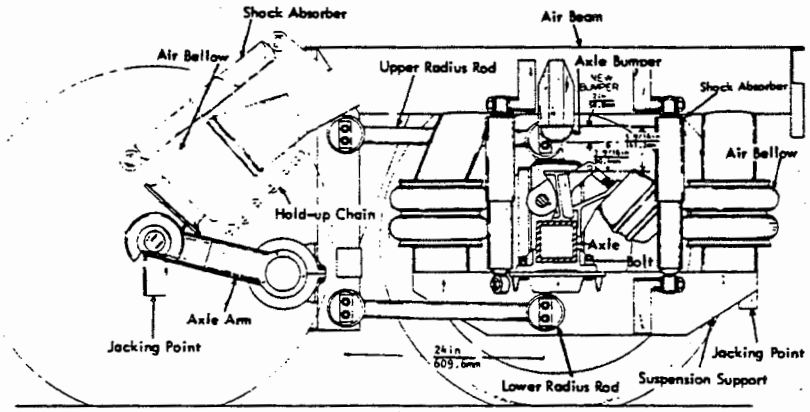


Figure 12-6B. Rear Suspension Effective Prior to Unit 41089.

HEIGHT CONTROL VALVES

The operation of the height control valves and the general design is detailed in Figure 12-7. The height control valves require no periodic maintenance. Height control valve linkage operates on rubber bushings and no lubrication at these points should be attempted.

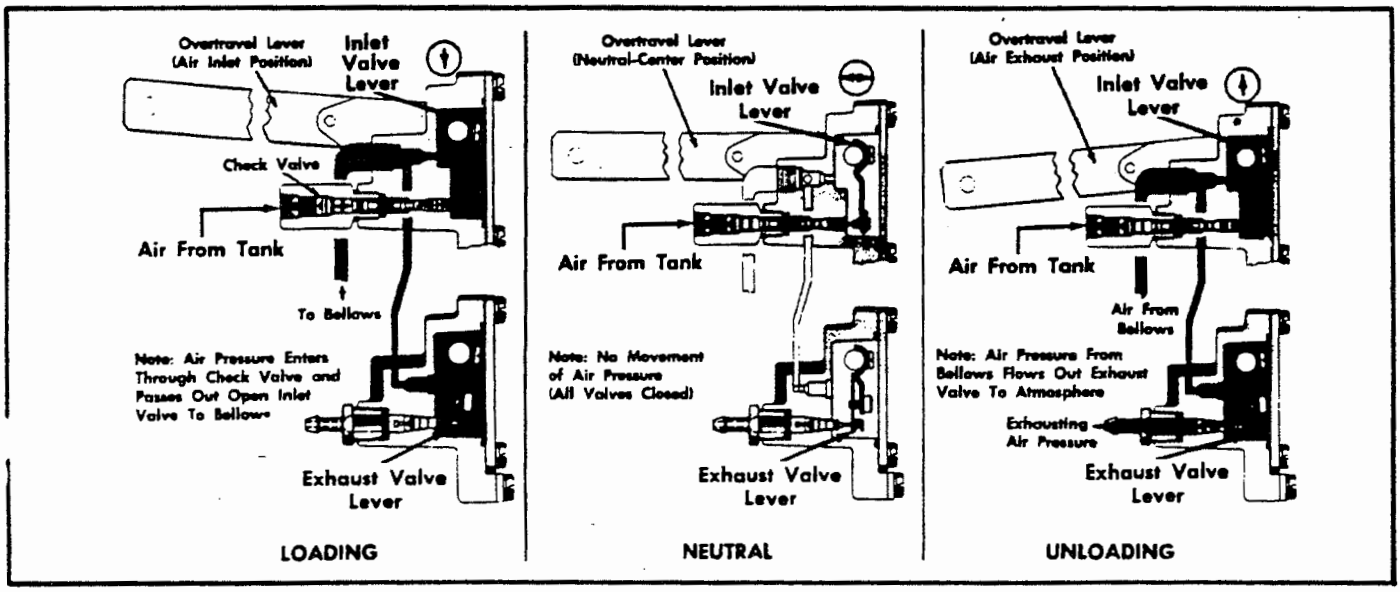


Figure 12-7. Height Control Valve Operation.

LOADING OPERATION

When loaded, the body of the coach settles. Since the height control valve is linked to the suspension, and the valve is mounted to the vehicle body, the valve moves downward with the body during loading. As the overtravel lever and control shaft turns, the intake valve lever presses against the pin of the valve core. As the pin is depressed, air pressure flows through the height control valve into the air springs. Increased the air pressure expands the air springs and raises the body of vehicle. The intake valve is protected by a check valve which permits air to travel in one direction only.

NEUTRAL POSITION

Increased pressure expands the air springs lifting the vehicle body and height control valve. The overtravel lever returns to "neutral" as vehicle body approaches normal ride height. The intake valve lever also moves the closing valve. The exhaust valve remains closed and the check valve in intake adapter prevents air from escaping from the valve body and air springs. This condition remains static until coach load is altered, moving the overtravel lever from "neutral" for one or more seconds actuating the intake or exhaust valves.

UNLOADING OPERATION

When the load is lightened, pressure in the air springs raises the coach body. Overtravel lever is pulled downward from "neutral." This applies a force that slowly moves the delay piston and opens the exhaust valve when the lever moves beyond free travel range. The intake valve remains closed allowing air from the air springs to exhaust to atmosphere. As air is exhausted from air springs, the vehicle body is lowered until the overtravel lever returns to neutral position.

When the coach is in motion with body at normal ride height, the overtravel lever is in neutral position. Small movements of the lever may occur without activating the control valve as it must move in excess of 3/16" (4.7 mm) before either the inlet or exhaust valve is opened.

The delay piston, connecting through a pin to overtravel shaft is contained in a cylinder of silicone fluid. The slowing action of this fluid delays by 1 to 6 seconds the closing of one valve to the opening of the other. The flapper valves allow both valves to close from full-open position within 1 second.

The overtravel piston is held against the shaft by two springs (one inside the other) and keeps the shaft in proper position relative to the overtravel lever. The purpose of the piston is to prevent damage of parts inside the control valve if the lever exceeds normal travel, and to allow the lever to move without moving parts inside the valve.

REMOVAL

1. Support coach by placing blocks under body at jacking points.

2. Open drain cock in air filter and vent all air from system.

3. Disconnect overtravel lever from link and pull down to exhaust remaining air from air beams.

4. Disconnect both lines from control valve and cover the ends with tape to prevent contamination.

5. Detach height control valve from mounting bracket.

Replacement is the reverse of removal. After assembly, check for leakage using soap and water solution.

LEAKAGE TEST

The following procedure is a leakage test when the valve assembly is removed from vehicle.

1. Clean the exterior of the valve assembly.

2. Connect air pressure line to air valve inlet port, then open the air pressure (70-100 psi; 483-690 kPa).

3. Dip the valve assembly in a container of water and watch for air bubbles when the overtravel lever is in the center position. No air should escape from any point of the valve assembly.

4. If bubbles appear from the bellows port, this is an indication that the air inlet valve assembly is defective and must be replaced.

5. Remove the air pressure line from the air inlet port and connect it to the bellows port. If bubbles appear at the air inlet check valve port, this is an indication that check valve unit is defective and must be replaced.

6. If bubbles appear at the exhaust port, it is an indication that the exhaust valve assembly is defective and must be replaced.

7. If bubbles appear around edge of the valve cover plate, the cover plate gasket should be replaced.

8. If no leaks are found, remove the valve assembly from the water, then with air pressure still connected to the bellows port, actuate the overtravel lever to remove any excessive amount of water which may have entered the exhaust valve chamber. Remove the air line and connect it to the air inlet port to remove water from the air inlet valve chamber.

MC-9 MAINTENANCE MANUAL

HEIGHT ADJUSTMENT

The correct coach body-to-axle clearance which should be maintained is shown in Figures 12-5 and 12-6. It should not be necessary to make an adjustment under normal service conditions. However, if an adjustment is necessary, it is made by changing the position of the overtravel lever in relation to the overtravel control body. The lever should be moved up to raise the level of the coach body, and down to lower it. Check that air pressure is above 100 psi (690 kPa) and raise coach to the specified height.

CAUTION: Always adjust on "fill cycle." If it is necessry to lower coach height, release sufficient air to be well below clearance and adjust to specified clearance.

NOTE: Ride height should be. rechecked after road testing.

When it is found that the coach is falling below the correct level after being parked for a period of time, the following procedure should be carried out:

1. Support coach by placing blocks under body at jacking points.

2. Open drain cock in air filter and vent all air from system.

3. Locate the suspension system height control valve which is applicable to the side of the coach which is low. One height control valve controls both front air beams or springs; the rear air beams or springs are controlled by two height control valves — one left hand side and one right hand side.

4. Disconnect the air line (inlet from air tank) and remove the adapter assembly (figure 12-8) and discard.

5. Remove the two small filter screens located behind the adapter assembly.

6. Clean with solvent and compressed air.

7. Replace the two small screens and install a new adapter and reconnect air line.

8. Charge the air system, remove the blocks and check the height control valve for leaks.

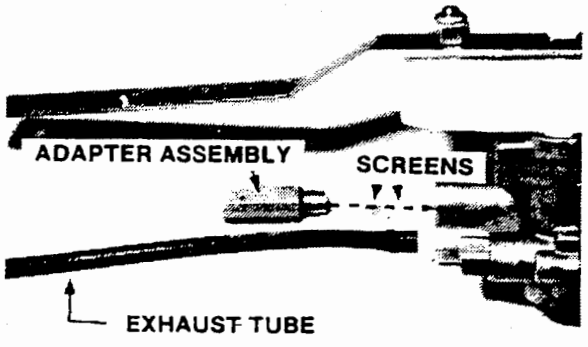


Figure 12-8. Height Control Valve Adapter and Screens.

OVERTRAVEL LEVER CENTER POSITION ADJUSTMENT

The following procedure is to adjust the overtravel lever:

1. Clean the exterior of the height control valve.

2. Remove delay piston retaining ring, cover, and O-ring from control valve assembly, then drain off the silicone fluid.

3. Remove exhaust fitting and exhaust screen from control valve.

4. Referring to figure 12-9, scribe a line 1-3/8" (34.9 mm) from plug end of overtravel lever control body.

5. Place valve assembly in vise as shown in figure 12-9.

6. If vacuum source is available, attach supply hose to valve exhaust port using Sun Tester fitting No. 115-3 or equivalent. Do not apply vacuum at this time.

7. Attach air pressure supply hose to air inlet port. Do not apply pressure at this time.

8. Locate dial indicator in position as shown in figure 12-9. Move overtravel lever to full air exhaust position — top of delay piston flush with top of bore — without overtraveling (position "C" Figure 12-10). Relocate indicator push rod to just contact 1-3/8" (34.9 mm) mark on control body and reset indicator dial to zero at this point (position C).

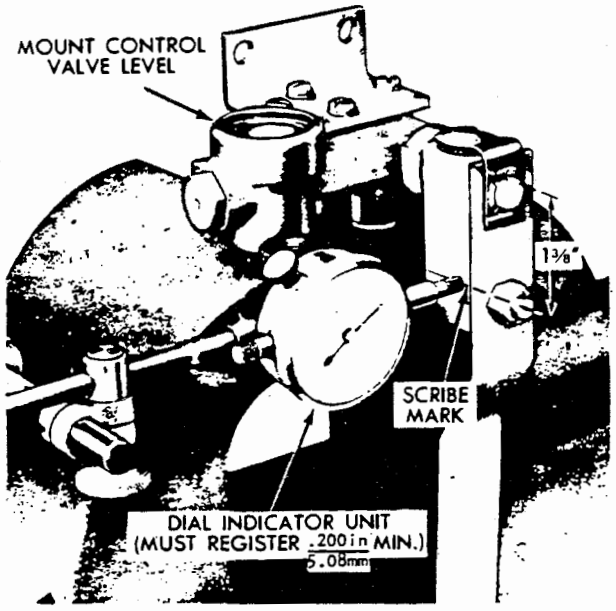


Figure 12-9. Dial Indicator Locations.

9. Move overtravel lever to full air intake position without overtraveling (position "A" Figure 12-10)(delay piston at bottom of bore). Take indicator reading which may vary 0.60" to 0.190" (1.52 mm - 4.82 mm).

10. Repeat steps 8 and 9 above to recheck this reading.

MC-9 MAINTENANCE MANUAL

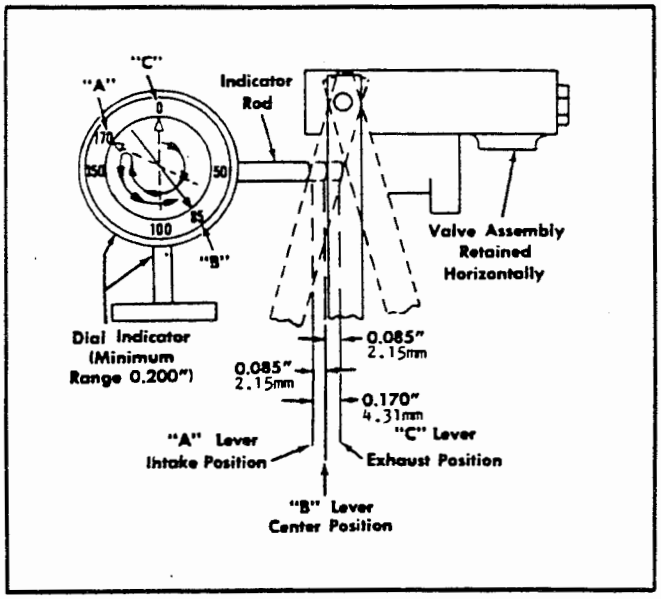


Figure 12-10. Locating Lever Center.

11. Divide the total travel dimension by two (example: 0.170" divided by 2 equals 0.085"; (4.31 mm divided by 2 equals 2.15 mm) to the center (position B).

12. Important: Without disturbing lever center position, reset indicator dial to zero, which actually is 0.100" (2.54 mm) on indicator of type registering 0.100" (2.54 mm) for each revolution of indicator needle, then proceed with valve lever gap adjustments following.

AIR INTAKE AND EXHAUST VALVE LEVER ADJUSTMENT

Two methods of adjustment are available:

1. Using both air pressure and vacuum — If vacuum source is available, this method will take less time to perform. Vacuum source is used to make the exhaust valve lever gap check only.

2. Using air pressure only — When this method is used, it will take longer to perform adjustments as the valve cover must be in place each time air pressure is applied and then removed to permit adjustment of exhaust valve lever.

Instructions covering lever adjustments are identical for front and rear valves. Rear valve lever and front valve lever must be bent to proper setting. In these valves both exhaust and intake levers are part of one unit which contains "score" marks to permit easy bending. Persons may accomplish this operation with lever in the valve body, or lever may be removed and bent on the bench.

NOTE: Before making these adjustments the overtravel lever must be centered as explained previously.

VACUUM METHOD

1. Apply available vacuum and regulate air pressure to approximately 95 psi (655 kPa).

2. Move overtravel lever fore and aft several times and then back to center position.

3. Starting at center position, slowly move lever to where air intake valve just begins to open. Listen for escaping air. Note reading on dial at this point. Reading should be 0.025-0.027" (.635-.685 mm) from lever center position. If necessary bend intake valve lever to correct setting, refer to figure 12-11.

4. Return overtravel lever to center position. Slowly move lever to exhaust side and at the same time note the vacuum gauge reading. When vacuum just begins to fall, the exhaust valve has opened. Valve should open when overtravel lever is moved 0.035" to 0.037" (.889-.940 mm) from center position. If necessary, bend exhaust valve lever to correct setting; refer to Figure 12-11.

AIR PRESSURE METHOD

This method may be performed when a vacuum source is not available.

1. Apply air pressure regulated to approximately 95 psi (655 kPa) to air inlet port.

2. To adjust air intake valve lever gap, move the overtravel lever slowly from center position to point where intake valve just begins to open. Listen for escaping air: Note reading on dial at this point which should register 0.025-0.027" (.635-.685 mm). If necessary, bend intake valve lever to correct setting. Refer to Figure 12-11.

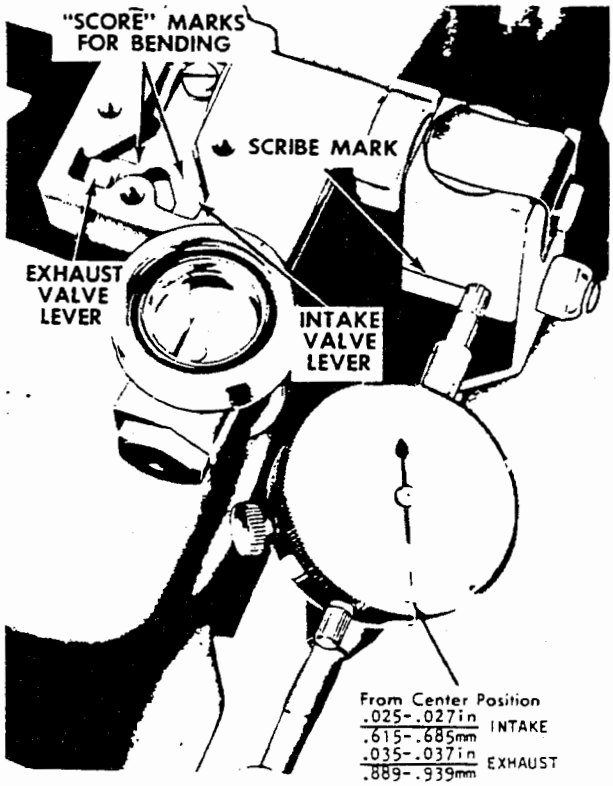


Figure 12-11. Adjusting Air Intake Valve Lever Gap.

3. To adjust air exhaust valve lever gap, install valve cover on the valve using a new gasket and four attaching screws. Be careful not to disturb indicator setting.

4. Disconnect air supply from the air inlet port and connect it to the air springs port.

5. Move overtravel lever slowly to open exhaust port while observing the indicator dial. Air should start to escape from the exhaust port when indicator registers 0.035-0.037" (.889-.940 mm).

6. If adjustment is necessary, shut off air pressure supply and remove valve cover. Bend exhaust valve lever to correct setting. Then install cover and re-check valve opening dimension.

TIME DELAY CHECK

After adjusting valve gaps check time-delay for opening and closing of valves (1-6 seconds one valve to opening of the other is recommended). Valves should close from full-open position within one second.

1. Place new O-ring over delay plug and install plug. Tighten to 20-30 inch-pounds (2.2-3.4 Nm) torque.

2. Pour 5.5 CC + 0.25 CC of Silicone fluid (750 centistokes Viscosity at 25°C) into delay piston chamber. With valve body tilted slightly as shown in Figure 12-12 carefully operate overtravel lever fore and aft to vent air from fluid. When all air has been expelled from piston pin cavity, check fluid level using depth gauge as shown in Figure 12-13.

NOTE: Use only No. S F96-1000 centistokes L-HF22 40 lbs. (5 gal.).

3. With valve assembly level take measurement from center of bore only. Add or remove fluid to bring fluid 13/64" (5.1 mm) from top of valve body. An eyedropper will serve this purpose.

4. Place new delay piston cover O-ring in groove of valve body. Install cover with retaining ring.

5. Place valve assembly vertically in holding vise. Refer to Figure 12-14.

6. Move overtravel lever up and down for approximately one minute.

AIR INTAKE TIME DELAY CHECK

1. Connect pressure line to valve intake port (figure 12-15) and open air pressure to 95 psi (655 kPa).

2. Move the overtravel lever upward quickly approximately 2" (50.8 mm) and simultaneously start counting the number of seconds before air starts to escape from the bellows ports. A delay of 1-6 seconds should exist. Repeat this check.

AIR EXHAUST TIME DELAY CHECK

To time the delay for exhaust, two methods can be used; one using vacuum source and one using air pressure. If vacuum source is available, perform steps 1 thru 3. If not, proceed to steps 4 thru 6.

Method Using Vacuum:

1. Install cover plate on height control valve using gasket.

2. Connect pressure line to air exhaust port and open air pressure to 95 psi (655 kPa).

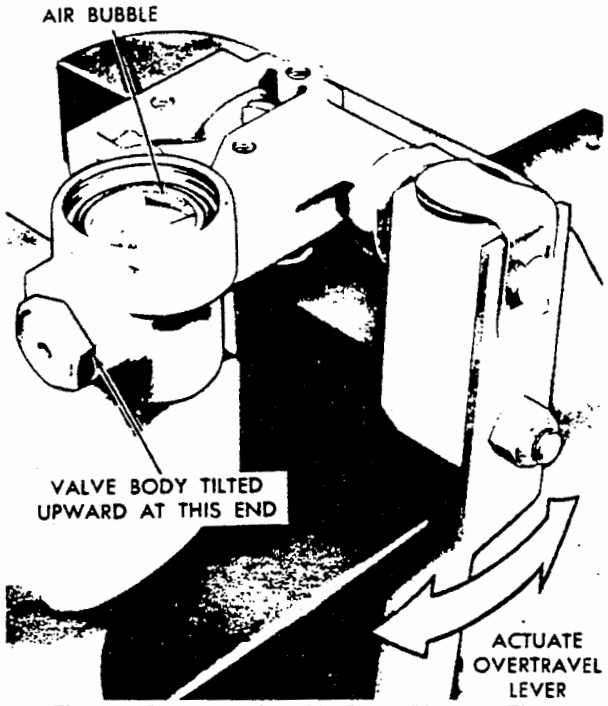


Figure 12-12. Venting Air From Silicone Fluid.

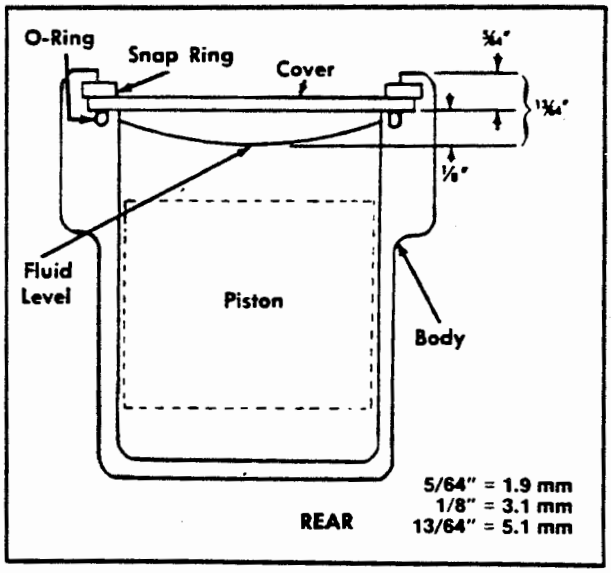


Figure 12-13. Measuring Silicone Fluid Level.

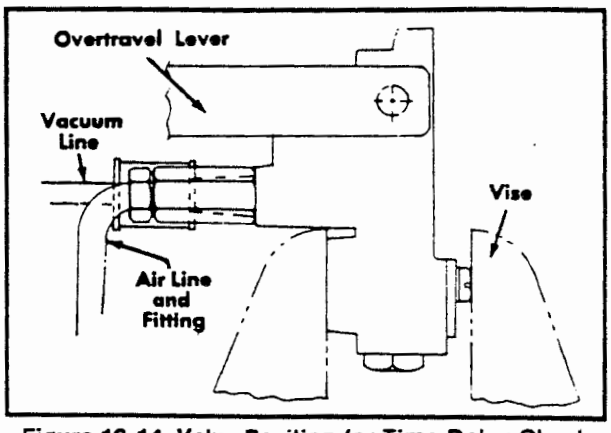


Figure 12-14. Valve Position for Time Delay Check.

3. Quickly move the overtravel lever downward approximately 2" (50.8 mm) and simultaneously start counting the number of seconds before the vacuum gauge starts to drop off. A delay of 1-6 seconds should exist.

Method Using Air Pressure:

4. Install valve cover with new gasket on valve assembly.

5. Connect air pressure supply hose to air spring port.

6. Move overtravel lever downward quickly approximately 2" (50.8 mm) and simultaneously start counting the seconds before air starts to escape from the exhaust port. A delay of 1 to 6 seconds should exist.

A time delay over 6 seconds could mean too large a valve lever gap adjustment and a time delay under 1 second would mean too small a valve lever gap adjustment. If the time delay is not within 1 to 6 seconds, first recheck the fluid level. If fluid level is satisfactory, the valve lever gap adjustment must be repeated as set forth previously.

After obtaining proper valve adjustments, install valve cover using new gasket. Install new screen in spring port. If screen was removed from exhaust port, install new screen and exhaust fitting.

Place tape over ends of air line ports until such time as valve assembly is installed on the vehicle.

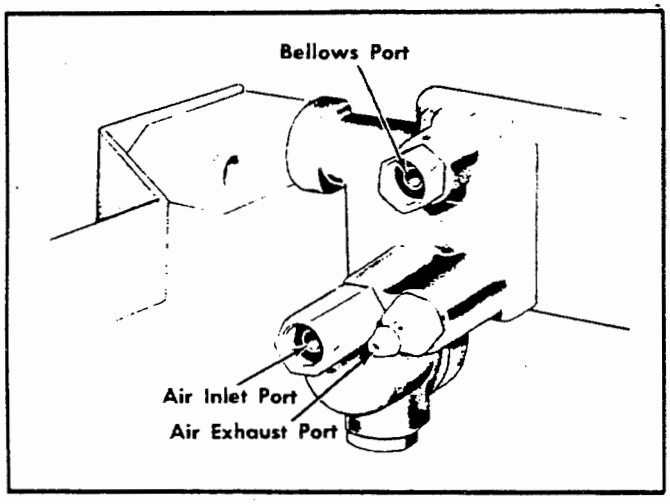


Figure 12-15. Height Control Valve Air Ports.

DISASSEMBLY OF HEIGHT CONTROL VALVE

Refer to Figure 12-16 for identification of parts.

1. Remove inlet adapter and check valve assembly (18) from valve body (10). Remove outlet adapter (20). Remove adapter O-rings (17). Remove air line fitting gasket (21) from adapters. Remove outlet adapter screen (19).

2. Remove four cover screws and lockwashers (1) from cover and bracket (2). Remove cover, bracket and gasket (6).

3. Position valve with delay plug (13) at top. Unscrew delay plug from valve body (10). Drain silicone fluid from cavity. Remove plug O-ring (12). Unscrew piston pin (11) from control shaft (23).

4. Remove delay cover retaining ring (35), cover (3) and cover O-ring (4). Remove delay piston (5). Discard O-ring.

5. Remove valve lever screw and lockwasher (7) from valve lever. Remove exhaust valve and intake valve lever (36) from valve body.

6. Remove valve stem lock clip (8) from stem of exhaust valve core. Spread locking arms and slide clip from around stem.

7. Pull overtravel assembly and shaft from valve body.

8. Remove intake valve core (9) with tool (TMC/MCI Part No. 20-35). See figure 12-17.

9. Remove exhaust fitting (16) and screen (15), then remove exhaust valve core (14) with tool (TMC/MCI Part No. 20-35).

10. Remove plug retainer (33) from overtravel control body (30). Retainer must be cut off. Use caution to avoid damage to nylon body. Remove overtravel body plug (25).

11. Place forked end of tool (TMC/MCI Part No. 20-36) around shaft in overtravel control body (30), then tighten clamp screw. Refer to figure 12-18.

CAUTION: Tighten tool until overtravel control shaft (23) can be turned 90° to allow notch in shaft to pass free of overtravel piston (26). Do not apply more pressure than is required.

Remove overtravel control shaft (23) and overtravel control body seal (29) from body. Remove shaft O-rings (22 & 24). Back off vise jaw and take body and tool from vise. Remove tool, overtravel piston (26), overtravel lever large spring (27), and overtravel lever small spring (28) from body. Remove lever screw nut (34) from overtravel lever screw or stud. Remove lever (23) from body.

CLEANING AND INSPECTION

1. The following parts should be discarded and replaced with new parts at each overhaul: Plug retainer (33), overtravel control body seal (29), gasket (6), and O-rings (22, 24, 17, 12 and 4).

2. Thoroughly clean all metallic parts in a suitable cleaning solvent. Dry with compressed air.

3. Inspect all bearings and rubbing surfaces for scoring, fractures or noticeable wear. Discard all damaged or worn parts and replace with new parts.

REASSEMBLY

CAUTION: Height control valve parts must be kept free from dirt and moisture.

1. Install intake valve core (9) and exhaust valve core (14) with screen (15) in control body (10) as shown in Figure 12-17. Tighten to 2-1/2 to 3 inch pounds torque (.28 to .33 Nm). Install exhaust fitting (16).

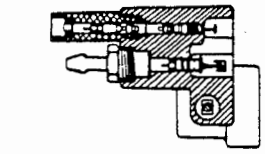
2. Lubricate overtravel control body with multipurpose grease.

3. Install lever (32) on control body. Place lever stud nut (34) on stud and torque to 70-80 inch pounds (8.0 to 9.0 Nm).

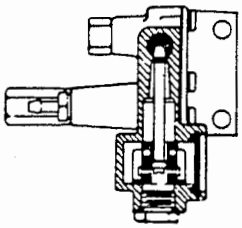
4. Place overtravel lever large spring (27), and overtravel lever small spring (28) inside piston (26). Insert piston in control body (30).

5. Place three new O-rings (22 and 24) on overtravel control shaft (23). Lubricate shaft and O-rings with multi-purpose grease.

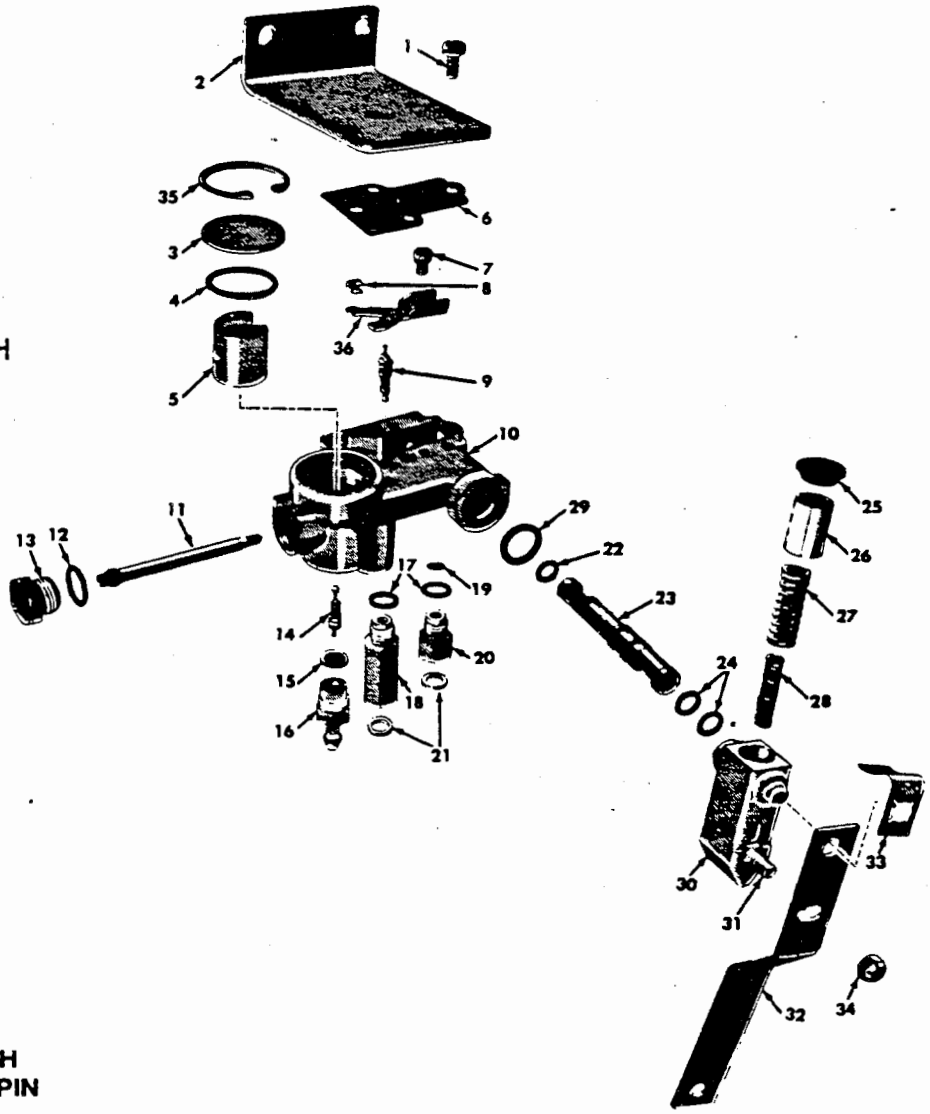
MC-9 MAINTENANCE MANUAL



SECTION THROUGH VALVES



SECTION THROUGH DELAY PISTON AND PIN



1. Cover Screw & Lock Washer
2. Cover & Bracket
3. Delay Cover
4. Delay Cover O-Ring
5. Delay Piston
6. Cover Gasket
7. Valve Lever Screw
8. Valve Stem Lock Clip
9. Intake Valve Core
10. Valve Body
11. Piston Pin
12. Plug O-Ring
13. Delay Plug
14. Exhaust Valve Core
15. Exhaust Screen
16. Exhaust Fitting
17. Adapter O-Ring
18. Inlet Adapter and Check Valve Assembly
19. Outlet Adapter Screen
20. Outlet Adapter
21. Airline Fitting Gasket
22. Shaft O-Ring (Medium)
23. Overtravel Control Shaft
24. Shaft O-Ring (Large)
25. Overtravel Body Plug
26. Overtravel Piston
27. Overtravel Spring (Large)
28. Overtravel Spring (Small)
29. Overtravel Control Body Seal
30. Overtravel Control Body
31. Overtravel Lever Stud
32. Overtravel Lever
33. Plug Retainer
34. Lever Stud Nut
35. Delay Cover Retainer
36. Intake & Exhaust Valve Lever

Figure 12-16. Height Control Valve Component Parts.

MC-9 MAINTENANCE MANUAL

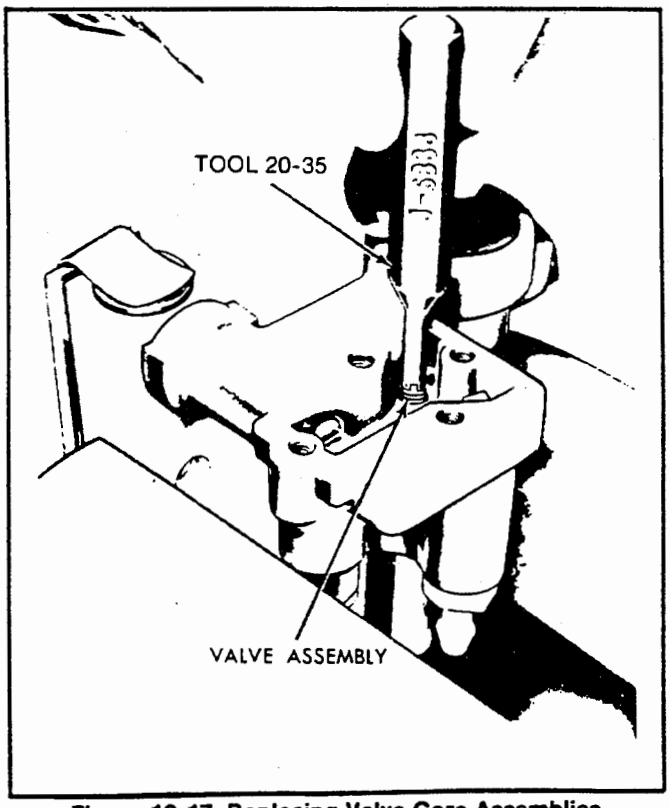


Figure 12-17. Replacing Valve Core Assemblies.

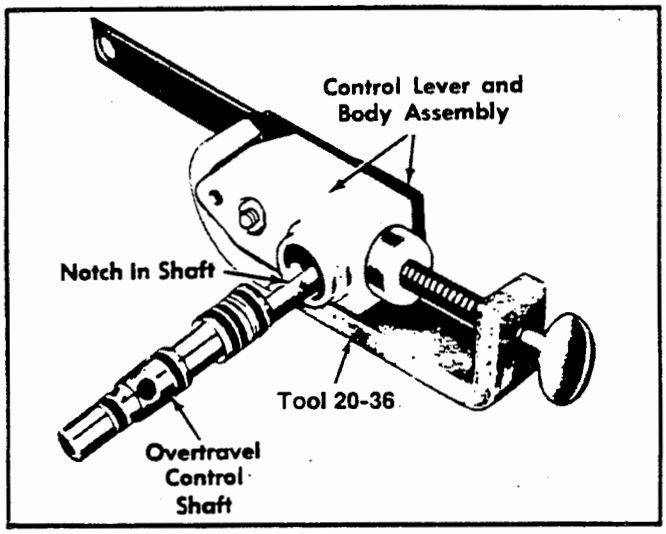


Figure 12-18. Replacing Overtravel Lever.

6. Position fork of tool 20-36 so that the shaft can be inserted in body (figure 12-18). Carefully apply pressure with clamp screw. Compress springs only enough to allow shaft to be inserted. Install overtravel control shaft (23). Rotate shaft so that flat is next to piston, and remove tool 20-36.

7. Insert overtravel body plug (25) in bore of body. Force new plug retainer (33) in position over nylon pivot and body plug (25).

8. Place new overtravel control body seal (29) on shoulder of body. Slide overtravel assembly into valve body (10). Insert carefully to avoid seal damage.

9. Place delay piston (5) in valve body with open side of piston toward the overtravel shaft (23).

10. Align pin openings in piston and in shaft. Fit piston pin (11) in tapered side of hole in shaft. Tighten pin to 70-80 inch pounds torque (8.0 to 9.0 Nm).

11. Place intake valve and exhaust valve lever (36) in position on overtravel shaft. Make sure the fork on the exhaust lever side is around stem of exhaust valve core (14). Fork should be high enough on stem so that stem will not be held open. Insert valve lever screw (7) and tighten to 8-10 inch pounds torque (.90 to 1.13 Nm).

12. Spread ends of valve stem lock clip (8) slightly and place on exhaust valve stem around stem head. Use suitable tool to brace stem and pinch ends of clip just enough to secure on stem. Clip must rotate freely on stem.

13. Using new O-ring (17), install air inlet adapter and check valve assembly (18) into valve body.

14. Make all of the valve assembly adjustments explained earlier in this section.

SHOCK ABSORBERS

The shock absorbers are double-acting type. They are of welded construction and cannot be repaired. Defective shock absorbers must be replaced with new units.

On MC-9 coaches prior to January 1988, the shock absorbers at front wheels and at the trailing wheels are identical and may be interchanged.

OPERATION

The operation of the shock absorber is relatively simple: Fluid contained within the shock absorber is forced through a restricted opening by a piston when the suspension air springs are flexed. The main function of the shock absorber is to regulate the vehicle axle travel by dampening the rebound motion.

REMOVAL AND REPLACEMENT

Two styles of shock absorbers are present on the coach.

One type has an eye at each end; the other has an eye at the upper end and a stud at the lower end. These stud-type shock absorbers are used only at the drive axle. Some of the earlier coaches have the stud-type shock absorber only in front of the drive axle; later coaches have them in front and behind the drive axle.

To remove the eye-mounted shocks, remove the nuts and washers from the shock absorber mounting pins. Withdraw the shock absorber assembly from the pins.

To remove the drive axle shocks, remove washers and nut from the eye end, and remove washers, nut and rubber bushings from the stud on the lower end of the shock. Withdraw the shock from the upper mounting pins, and lift stud end out of mounting hole in the suspension support.

New rubber mounting bushings should be used when the shock absorbers are replaced. This applies to both the eye and pin connections and to the stud connection.

MC-9 MAINTENANCE MANUAL

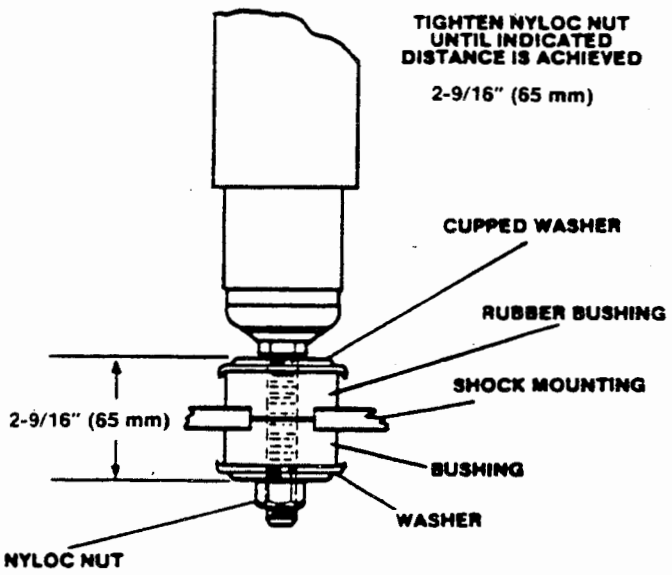


Figure 12-19. Stud Mounted Drive Axle Shock Installation.

Replacement is the reversal of removal. Tighten the mounting nuts at the eye end of the shock absorbers to 150-160 foot-pounds (203-216.96 Nm) torque. Tighten the nut on the stud end of the drive axle shock absorbers until the distance between the cupped washers is 2-9/16" (65 mm). Refer to figure 12-19.

MAIN SUSPENSION AIR FILTER

The purpose of the Type E air filter (figure 12-20) is to keep the suspension and accessory air system free from foreign matter. It is located on a mounting strap on the right hand front air tank with the air filter itself facing inside between the right and left front air tanks.

The filter element and cover gasket should be replaced approximately every 50,000 miles (80,000 km) under average operating conditions. It may be necessary to change the element and gasket more or less frequently depending on the amount of dirt and sludge, etc., accumulated in the filter. It is also recommended that the change be made prior to seasonal freezing temperatures to prevent the element from freezing due to possible water sludge in the system.

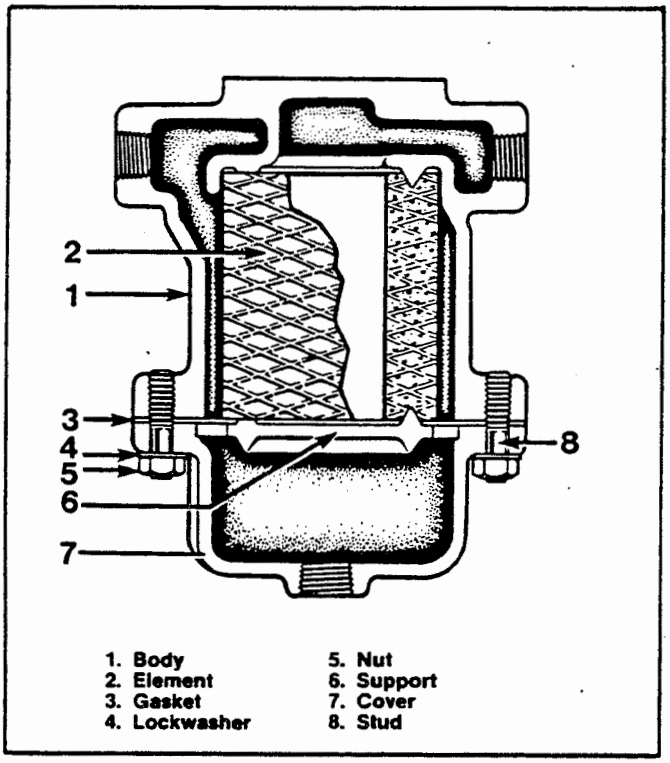


Figure 12-20. Type "E" Air Filter.

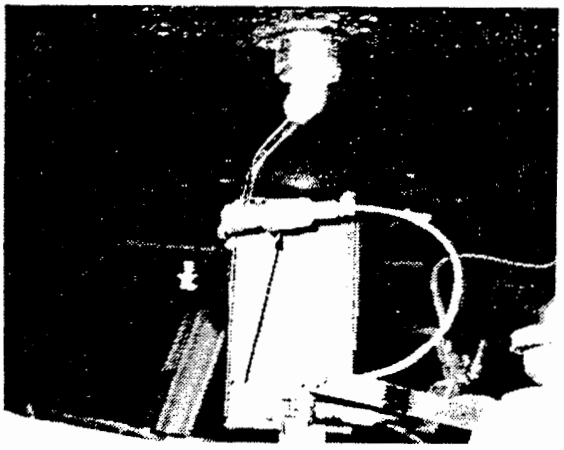


Figure 12-21. Air Line Filter Installed.

SUSPENSION AIR FILTERS

Maintenance of the filtration in the air suspension system is of prime importance. Two air filters are located between the rear suspension height control valves and the left and right air springs. One air filter is located ahead of the tee fitting between the left and right air beams/or air springs and front height control valve in the front suspension (figure 12-21). These filters prevent the entrance of foreign matter from the air beams/or air spring and suspension members, into the height control valve when the air pressure is exhausted from the system.

MC-9 MAINTENANCE MANUAL

The air filter and check valve assembly is used at the inlet port of each height control valve. These filters exclude foreign matter and the check valve assembly prevents air pressure from returning to the auxiliary air system. Regular service intervals should be maintained on these assemblies. If the filter elements become clogged they will retard the air flow in and out of the system.

REMOVAL AND DISASSEMBLY

1. Install blocks under coach at jacking points and exhaust air from auxiliary system by opening drain cock on auxiliary air tank.
2. Remove height control valve link. Do not disturb link adjustment.
3. Move control arm down to exhaust air from air springs and/or air beams.
4. Disconnect air lines from air filters.
5. Disconnect air lines from filter and check valve assemblies.
6. Remove filter from control valve.
7. Cover inlet port of control valve to prevent entry of dust and dirt.
8. Clamp filter in vise and remove filter element and gasket from body. See figure 12-22.
9. Clamp the air filter and check valve in the vise with filter cover up.
10. Remove cover from body and remove filter element. Use end wrench on check valve cap and remove cap from body.
11. Lift check valve spring out of body and remove body from vise. Check valve is then loose.

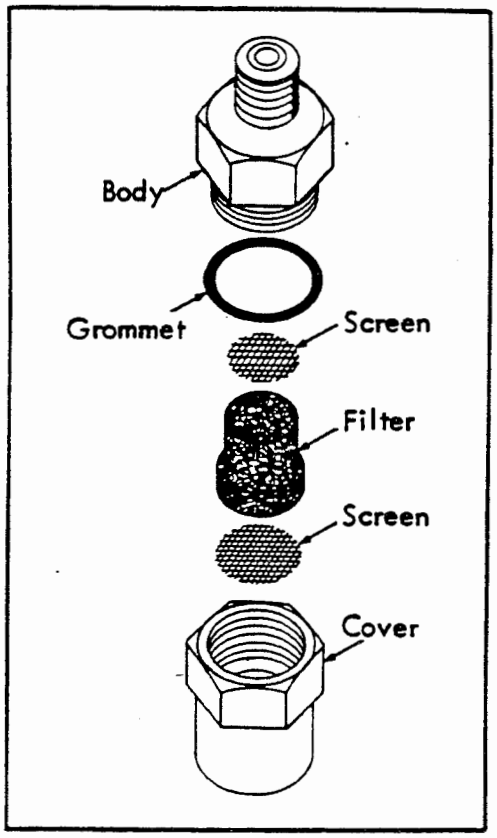


Figure 12-22. Air Line Filter Components.

INSPECTION

1. Examine bronze filter elements and immerse all parts in cleaning solvent and wash thoroughly.
2. Blow out all parts with compressed air and blow air through bronze filters.
3. Examine check valve seat. Seat must be clean and free from scratches or damage.
4. If seat is damaged, replace body. Always use new gaskets on reassembly.

REASSEMBLY

1. Clamp air filter body in vise, large end up.
2. Apply Lubriplate to new gasket and at bottom of threads on filter body.
3. Place on filter element with the small end up and place spring over filter.
4. Tighten filter cover on to the body firmly.
5. On filter and check valve install filter in same manner into filter and check valve body. Check valve may then be dropped into body with flat side down against seat.
6. Place spring over raised center.
7. Install gasket on check valve cap and tighten cap firmly into the check valve end of the body.

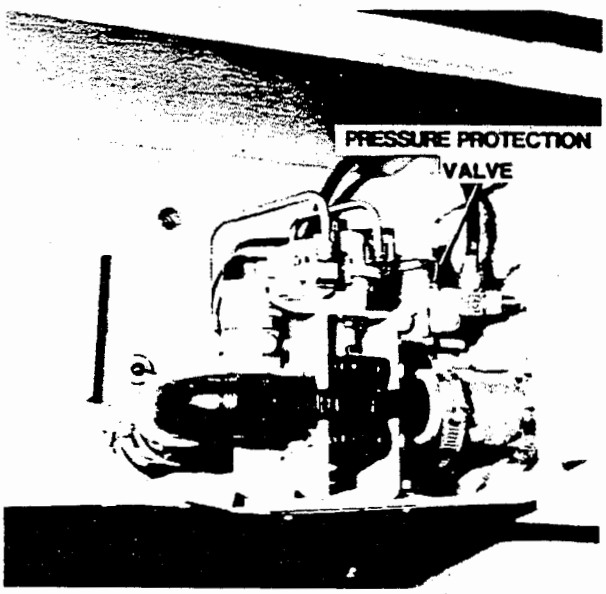


Figure 12-23. Pressure Protection Valve Installation.

MC-9 MAINTENANCE MANUAL

PRESSURE PROTECTION VALVE

On the MC-9 the valve is located in the right hand front baggage compartment above and behind the main water valve (figure 12-23).

The pressure protection valve controls the pressure at which compressed air is delivered to the system. The valve remains closed until a pre-set supply pressure is reached (65 psi, 448 kPa). It then opens and passes air to the delivery port.

The chief use for this valve is to protect the main air system, to control the amount of air taken from the main air brake system to operate auxiliary devices. By locating the pressure protection valve between the dry air tank and park brake air tank, air is maintained in the main air brake system before being supplied to the park brake air tank for quick build-up for emergency applications.

The pressure protection valve has a ¼" (6.35 mm) delivery port on the bottom and a ¼" (6.35 mm) supply port on the side. Two 9/32" (7.15 mm) mounting holes are cast into the body for mounting purposes if required. See figure 12-24.

OPERATION

Compressed air enters the supply port, and is stopped by the closed inlet valve. When the air pressure entering the supply port overcomes the pressure setting of the spring above the piston, the piston moves upward. The inlet valve opens, allowing air to pass out the delivery port.

When air pressure underneath the piston is reduced to a lesser force than that of the spring above it, the spring forces the piston down, closing the inlet valve and stopping further flow of air through the delivery port of the valve.

The pressure setting is determined by the force of the spring which is controlled by the cap on the top of the valve. Turning the cap clockwise raises the pressure setting; turning the cap counterclockwise lowers the pressure setting. The lock nut must be tightened after each adjustment.

MAINTENANCE

Every 6 months or 30,000 miles (48,000 km), connect a test gauge to the delivery line and check the pressure setting by observing at what pressure valve closes by venting the delivery system. If the pressure setting varies more than 5 psi (34 kPa) from the specified setting (65 psi, 448 kPa), adjust the valve. (See Operating and Leakage Checks.) Tighten lock nut after each adjustment.

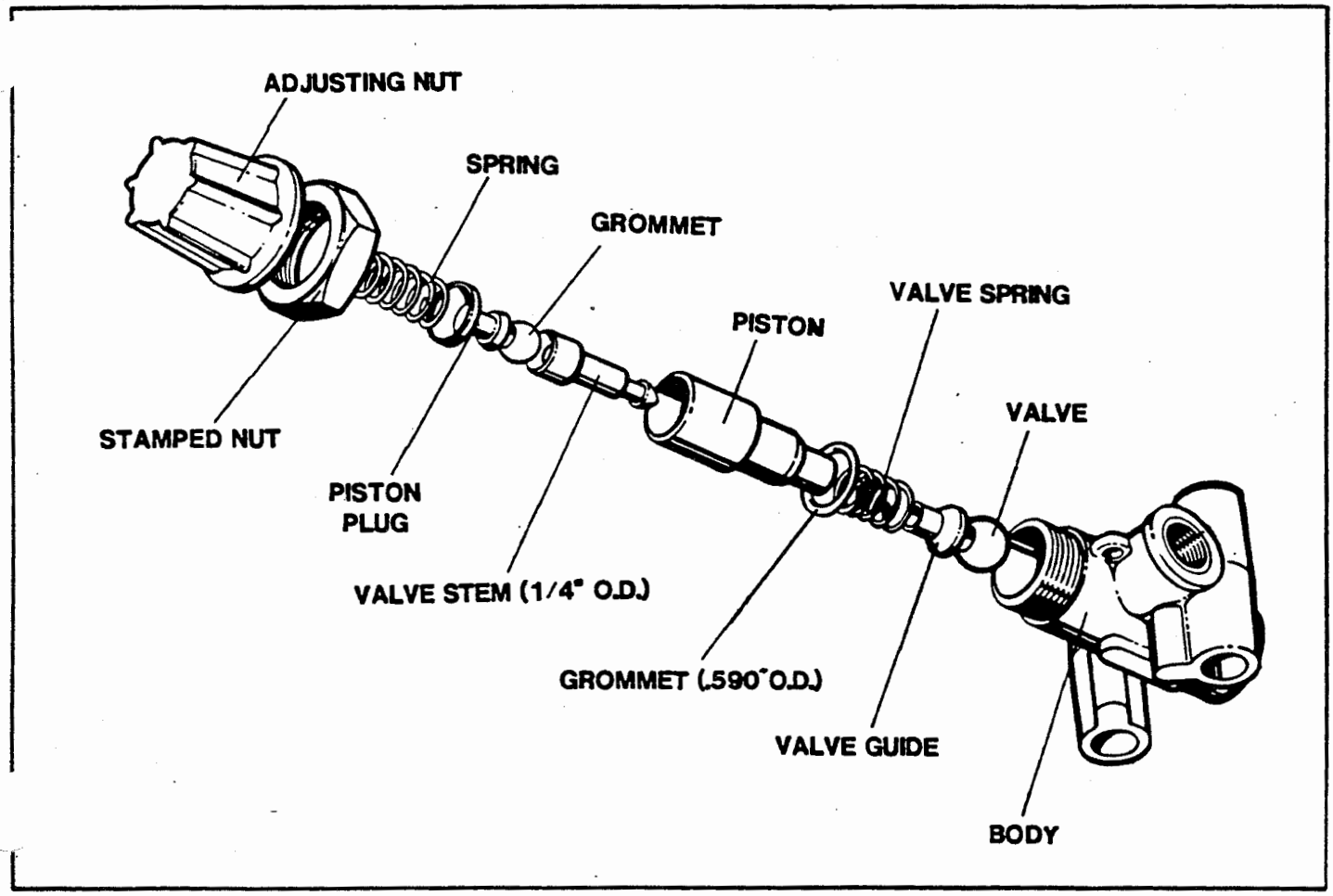


Figure 12-24. Pressure Protection Valve Parts Breakdown.

Every year or 100,000 miles (161,000 km), dismantle the valve and clean all parts. Replace rubber parts showing signs of wear. Assemble the valve, check and adjust valve to specified setting (65 psi, 448 kPa).

OPERATING AND LEAKAGE CHECKS

1. Remove the pressure protection valve from the vehicle.
2. Mount the valve with a variable air supply and a small delivery volume.
3. Connect an accurate gauge in both the supply and delivery lines.
4. Increase supply pressure until the gauge in the delivery line equals that of the gauge in the supply line.
5. Close the supply line and vent the delivery line. Note supply pressure when the valve closes which is indicated by the drop of pressure at the delivery line gauge.
6. Adjust valve if pressure setting varies more than 5 psi (34 kPa)) from the specified setting of 65 psi (448 kPa).
7. With supply pressure at approximately 100 psi (690 kPa), soap the area around the slot in the adjusting cap. No leakage is permitted. Leakage at this point would indicate a leaking piston O-ring or piston plug O-ring.
8. Vent the delivery line, and check for leakage. No leakage is permissible. Leakage at this point would indicate a faulty inlet valve.

If the pressure protection valve does not function as described, or leakage is excessive, it should be repaired.

REMOVAL AND DISASSEMBLY

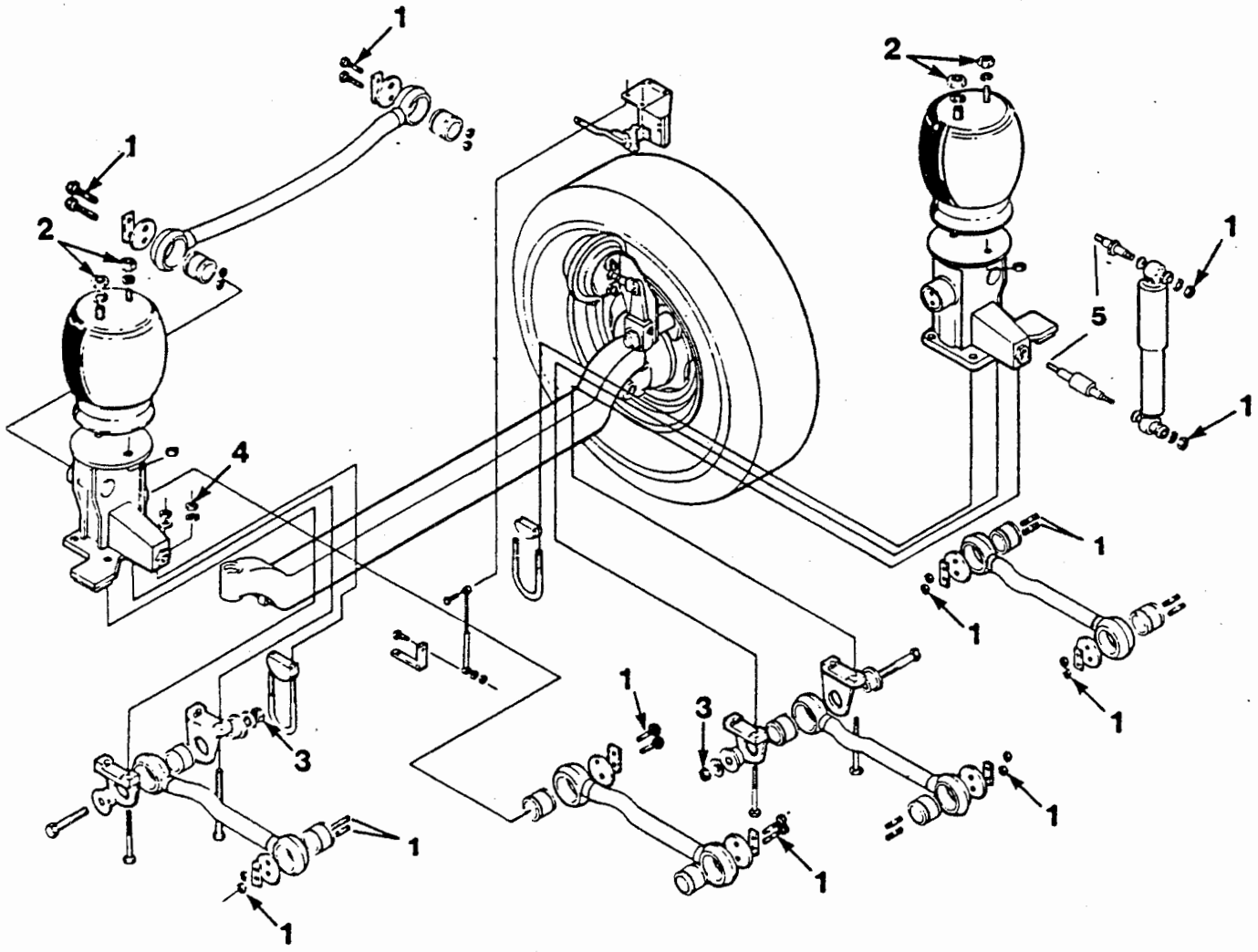
1. Block and hold the vehicle by means other than air brakes.
2. Drain dry and wet air tanks.
3. Disconnect all air lines from the pressure protection valve.
4. Loosen valve and remove. Check and clean air lines to valve.
5. Loosen lock nut and remove adjusting cap, then lock nut.
6. Remove pressure regulating spring.
7. Remove piston and inlet valve assembly from the body.
8. Remove inlet valve from stem, spring retainer and inlet valve spring.
9. Turn the piston over and depress the inlet valve stem fully. This will loosen piston plug with O-ring from center of piston.
10. Remove piston O-ring.

CLEANING, INSPECTION AND ASSEMBLY

1. Wash metal parts in a good cleaning solvent. Rubber parts such as O-rings should be wiped clean.
2. Inspect all parts for wear or deterioration.
3. Check spring for cracks, corrosion or distortion.
4. Inspect all rubber parts and replace if they show signs of cracks, wear, deterioration or are swollen.
5. Before assembling, lubricate the piston, O-rings and body bores with lubricant BW-204-M (TMC/MCI Part No. 4A-15-113).
6. Install valve stem in piston.
7. Put small O-ring on the piston plug. Install piston plug pressing snugly into piston body.
8. Install inlet valve spring, spring retainer and snap on rubber inlet valve.
9. Slip piston O-ring on end of piston and move to the shoulder of the body.
10. Insert the piston into the valve body carefully so as not to cut O-ring.
11. Place spring into center of piston.
12. Replace adjusting cap lock nut and replace adjusting cap nut.

Perform the operating and leakage tests detailed previously.

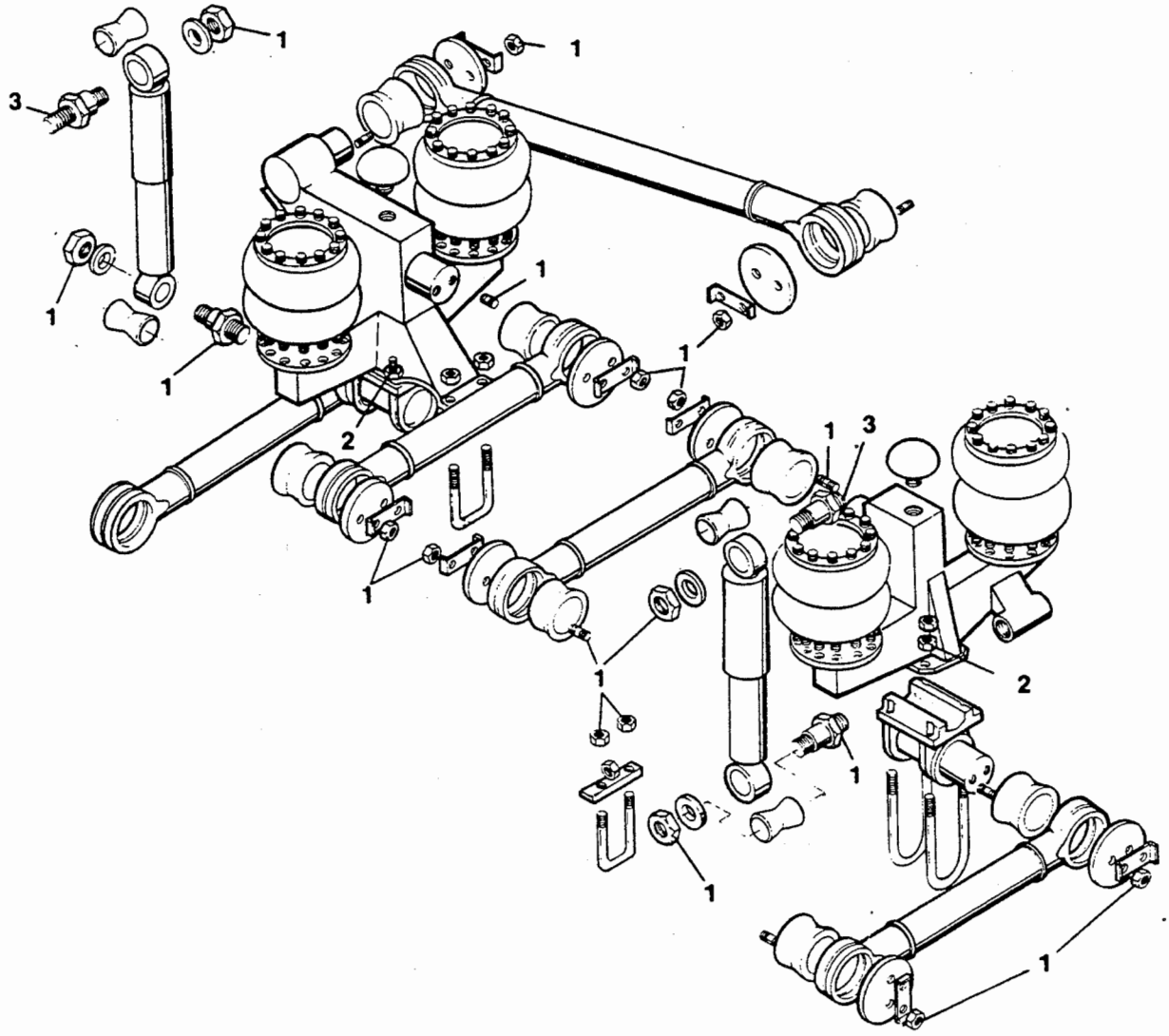
MC-9 MAINTENANCE MANUAL



1. 150-165 ft. lbs. (203.4-223.7 Nm)
2. 55-65 ft. lbs. (74.6-88.1 Nm)
3. 350 ft. lbs. (474.6 Nm)
4. 160-170 ft. lbs. (217.0-230.5 Nm)
5. 325-350 ft. lbs. (441-475 Nm)

Figure 12-25A. Front Suspension Torque Recommendations (Effective with Unit 41089).

MC-9 MAINTENANCE MANUAL



1. 150-165 ft. lbs. (203-224 Nm)
2. 160-170 ft. lbs. (217-231 Nm)
3. 325-350 ft. lbs. (441-475 Nm)

Figure 12-25B. Front Suspension Torque Recommendations (Effective prior to Unit 41089).

MC-9 MAINTENANCE MANUAL

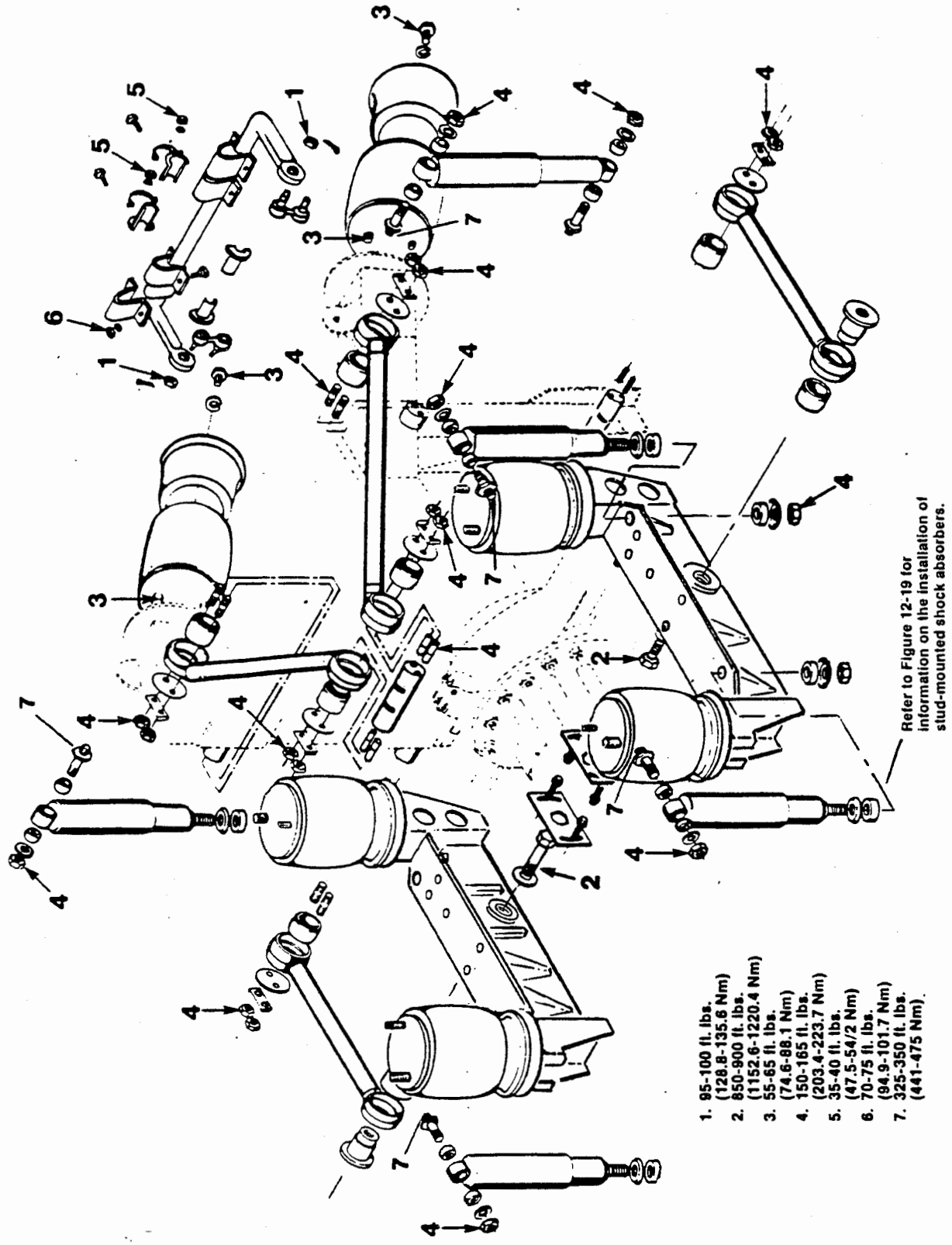

1. 95-100 ft. lbs. (128.8-135.6 Nm)
2. 850-900 ft. lbs. (1152.6-1220.4 Nm)
3. 55-65 ft. lbs. (74.6-88.1 Nm)
4. 150-165 ft. lbs. (203.4-223.7 Nm)
5. 35-40 ft. lbs. (47.5-54/2 Nm)
6. 70-75 ft. lbs. (94.9-101.7 Nm)
7. 325-350 ft. lbs. (441-475 Nm).
Refer to Figure 12-19 for information on the installation of stud-mounted shock absorbers.

Figure 12-26A. Rear Suspension Torque Recommendations (Effective with Unit 41089).

MC-9 MAINTENANCE MANUAL

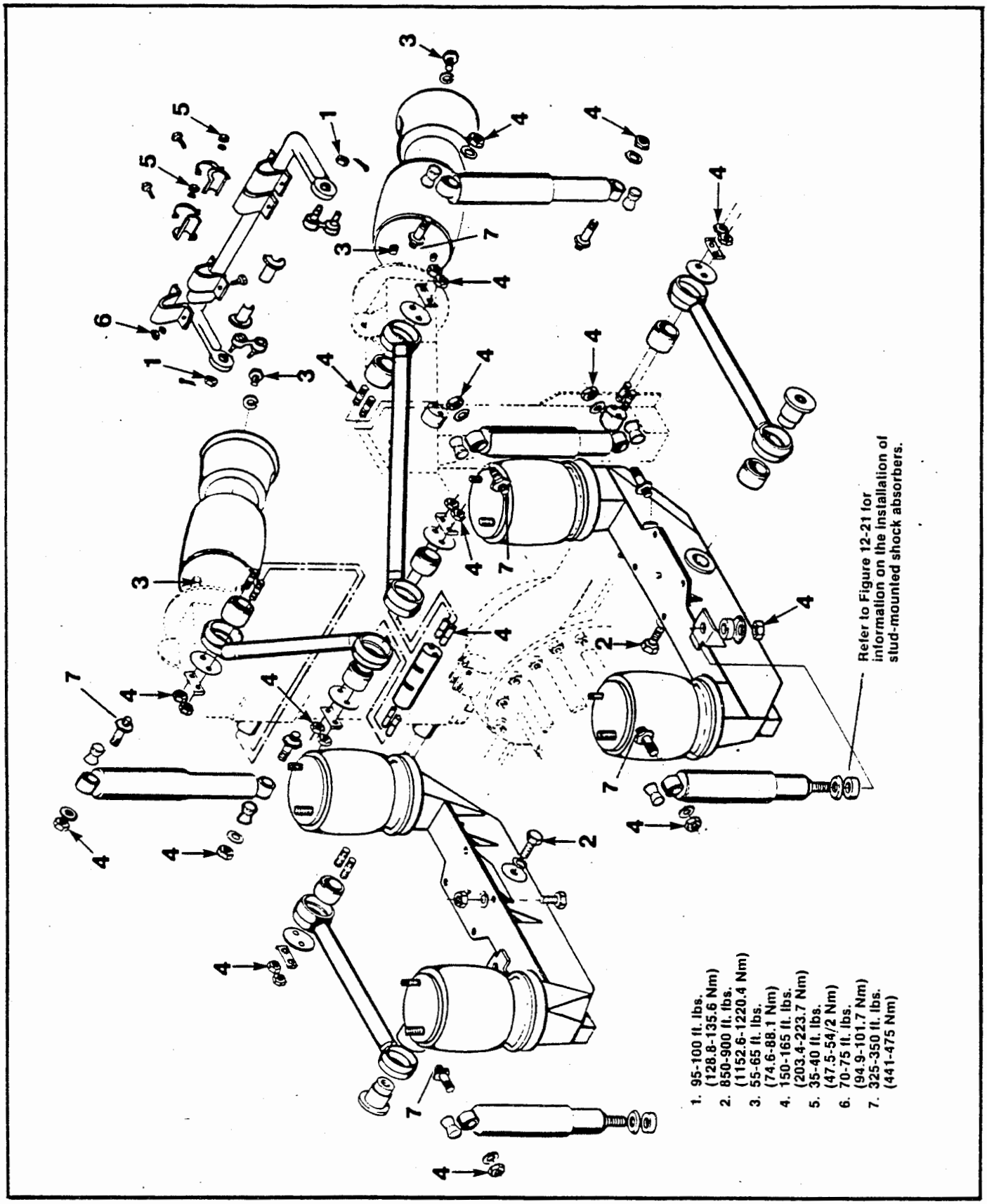

1. 95-100 ft. lbs. (128.8-135.6 Nm)
2. 850-900 ft. lbs. (1152.6-1220.4 Nm)
3. 55-65 ft. lbs. (74.6-88.1 Nm)
4. 150-165 ft. lbs. (203.4-223.7 Nm)
5. 35-40 ft. lbs. (47.5-54/2 Nm)
6. 70-75 ft. lbs. (94.9-101.7 Nm)
7. 325-350 ft. lbs. (441-475 Nm)
Refer to Figure 12-21 for information on the installation of stud-mounted shock absorbers.

Figure 12-26B. Rear Suspension Torque Recommendations (Effective prior to Unit 41089).

MC-9 MAINTENANCE MANUAL

SPECIFICATIONS

SUSPENSION AIR SPRINGS (FRONT & REAR AXLES) (Prior to unit 41089)

Make	Firestone
Type	Double-Convolution
No. Convolutions	Two
Diameter, Front	9" (228 mm)
Diameter, Rear	12" (305 mm)

SUSPENSION AIR SPRINGS (TRAILING AXLE)

Make	Firestone
Type	Rolling Lobe
Diameter	11" (279 mm)

SUSPENSION AIR SPRINGS (FRONT AXLE) (Effective with unit 41089)

Make	Goodyear, Firestone
Type	Rolling Lobe
Diameter, Front	12" (305 mm)

SUSPENSION AIR SPRINGS (DRIVE AXLE) (Effective with unit 41089)

Make	Goodyear, Firestone
Type	Rolling Lobe
Diameter	12" (305 mm)

HEIGHT CONTROL VALVES

Make	Delco
Quantity used, Front	1
Quantity used, Rear	2

SHOCK ABSORBERS (Prior to unit 41089)

Make	Delco, Gabriel
Type	1-3/4" (44.45 mm) dia. Cyl. Double Acting
Model No.	F450W
Valve Code	3(1)N 10/J3
Collapsed Length	16-5/8" (422.275 mm)
Extended Length	26-5/8" (676.275 mm)
Travel	10" (254 mm)
Number Used	2 Front; 4 Rear Drive; 2 Rear Trailing

SHOCK ABSORBERS (FRONT AXLE) (Effective with unit 41089)

Make	Delco, Gabriel
Collapsed Length	16.64" (422.656 mm)
Extended Length	26.14" (663.956 mm)
Quantity used	2

SHOCK ABSORBERS FRONT OF DRIVE AXLE (Effective with unit 41089) & TRAILING AXLE

Make	Delco, Gabriel
Collapsed Length	16.28" (413.512 mm)
Extended Length	26.17" (664.718 mm)
Quantity used	2

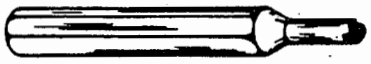
SHOCK ABSORBERS (REAR OF DRIVE AXLE) (Effective with unit 41089)

Make	Delco, Gabriel
Collapsed Length	14.85" (377.19 mm)
Extended Length	23.61" (599.694 mm)
Quantity used	2

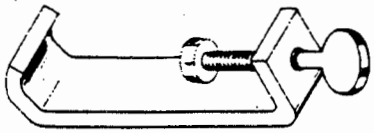
MC-9 MAINTENANCE MANUAL

SERVICE TOOLS

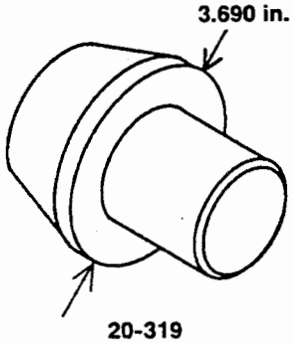
Many of the tools listed in this section are specially designed to meet the needs of various service operations. They are available for purchase through Motor Coach Industries, Service Parts Division, and Universal Coach Parts or, where practical, may be fabricated by the operator. In these cases, drawings are available upon request.



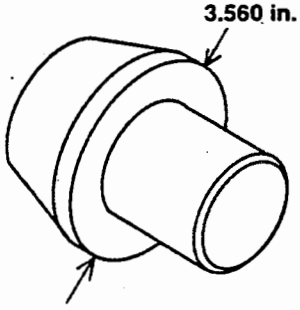
20-25 Valve Replacement Tool — For Control Valve



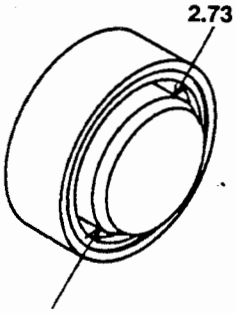
20-36 Tool - Height Control Valve Overtravel Lever (Piston Compressor)



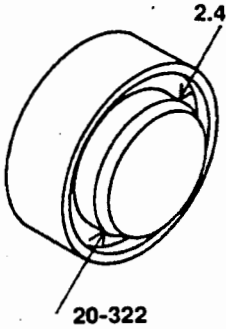
20-319
Removal Tool for Radius Rod Bushing 12J-1-35



20-321
Removal tool for Radius Rod Bushing 12J-1-26



20-320
Installation Tool for Radius Rod Bushing 12J-1-35



20-322
Installation Tool for Radius Rod bushing 12J-1-26

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Date 1-1-89

MC-9 MAINTENANCE MANUAL

SECTION 13

TRANSMISSION

SUBJECT	PAGE
5-Speed Manual Transmission	13-1
Changing Input Shaft	13-20
Clutch Housing Installation	13-41
Clutch Housing Removal	13-9
Companion Flange or Yoke Installation	13-42
Companion Flange or Yoke Removal	13-6
Countershaft Bearing Removal	13-11
Countershaft Partial Installation	13-26
Countershaft Reassembly	13-24
Disassembly - General Information	13-2
Drive Gear Removal	13-17
Left Countershaft Installation Completion	13-28
Left Reverse Idler Gear Reassembly and Installation	13-38
Left Reverse Idler Gear Removal	13-10
Main Drive Gear Reassembly and Installation	13-26
Mainshaft Installation Completion	13-38
Mainshaft Partial Installation	13-36
Mainshaft Reassembly	13-30
Mainshaft Removal and Disassembly	13-13
Maintenance	13-1
Oil Changing	13-2
Output Shaft Partial Reassembly	13-30
Output Shaft Reassembly and Installation Completion	13-39
Rear Bearing Cover Reassembly and Installation	13-42
Rear Bearing Cover Removal	13-6
Reassembly - General Information	13-22
Right Countershaft Installation Completion	13-37
Right Reverse Idler Gear Reassembly and Installation	13-23
Specifications	13-47
Timing	13-22
Transmission Parts Inspection	13-22
Transmission Removal	13-2
Remote Control Housing Remova.	13-2
Remote Control Housing and Shifter Housing Installation	13-46
Shift Bar Housing Installation	13-45
Shift Bar Housing Reassembly	13-43
Shift Bar Housing Removal and Disassembly	13-4
Shift Linkage Adjustment	13-46
Service Tools	13-50
Automatic Transmission	13-48
Modulator Valve Installation	13-48
Transmission Filter Change	13-48
Service Bulletin Page	

MC-9 MAINTENANCE MANUAL

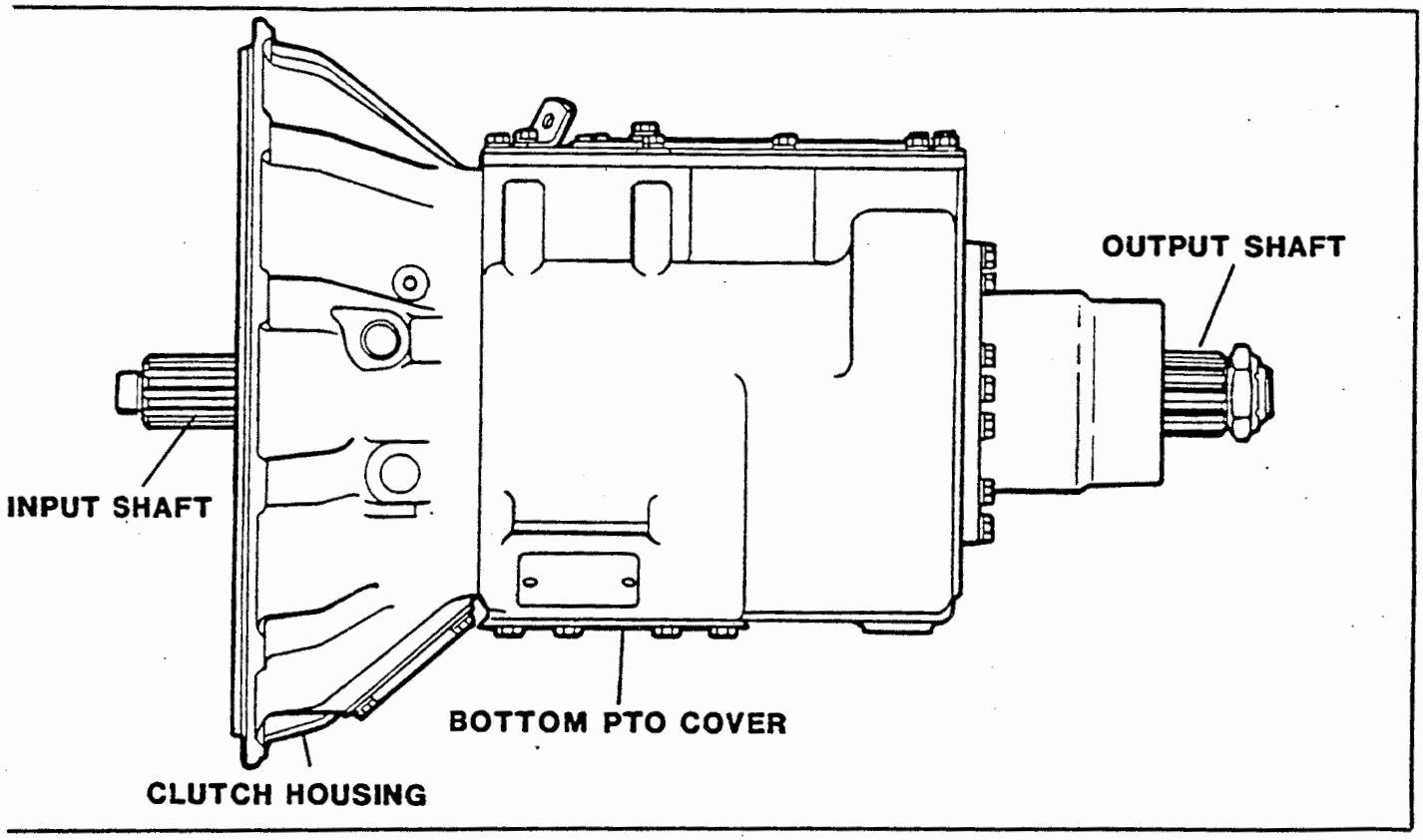


Figure 13-1. T-11605 Transmission.

5-SPEED MANUAL TRANSMISSION

The model 11605 transmission (figure 13-1) has five forward speeds and one reverse. Figure 13-2 shows the shift pattern. Twin countershafts divide the torque equally between shafts and gears. The countershafts are identical except for the PTO gears.

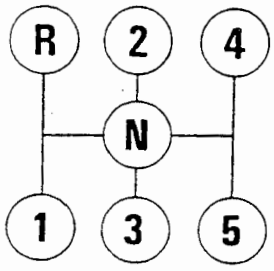


Figure 13-2. 5-Speed Shift Pattern.

The mainshaft gears are located axially by washers and held in position by the rotation of the countershaft gears. All gears have spur type teeth.

The mainshaft gears are clutched by internal splines in the hubs of gears. Sliding clutch gears with short, conical clutching teeth provide short, easy shifts.

The input shaft and drive gear are not integral and may be changed individually.

The transmission is splash lubricated by oil contained in the case. Two magnetic oil plugs are located on the bottom of the case to collect any metallic particles that are present in the oil. The filler tube and dipstick are accessible through the left side engine compartment service door.

The Model T-11605F manual transmission, which is optional, is often installed in conjunction with drive axles having 3.33 or 3.85 gear ratios. This combination is for greater fuel economy. The transmission differs from the T-11605D in the first through fourth gear ratios; see specifications at the end of this section.

MAINTENANCE

A proper lubrication schedule is essential to ensure maximum performance of the transmission.

On new coaches, the "factory fill" lubricant should be changed between the first 3,000 and 5,000 miles (4,827 to 8,045 km). During initial operation tiny metal particles are freed from the mating surfaces of moving parts. The lubricant carries these particles through the transmission causing wear on all parts. When draining the transmission, remove all metal particles that are picked up by the magnetic drain plug.

Draining the factory fill lubricant before the first 5,000 miles (8,045 km) also prevents oil contamination caused by the differences between factory fill lubricant and the lubricant used by the operator for topping up the level.

At intervals of 5,000 miles (8,045 km) check the dipstick to ensure the oil is at proper level. Inspect for leaks. At intervals of 50,000 miles (80,450 km) the transmission oil should be changed.

TRANSMISSION OIL CHANGE

While the oil is warm, remove the magnetic drain plug at the bottom of the case to drain the oil. Thoroughly clean the plug before re-installing.

When refilling the transmission, refer to the chart (figure 13-3) to determine the correct type of lubricant. Factory fill is 22 U.S. pints (10.41 liters) of SAE-50 heavy duty engine oil.

Do not overfill the transmission as this will cause fluid to be forced out of the case through the mainshaft openings. Also, types and brands of oil should not be intermixed because of possible oil component breakdown and loss of lubrication protection.

RECOMMENDED LUBRICANTS

Type	Grade (SAE)	Ambient Temperature
Heavy Duty Engine Oil	50	Above 10°F (12°C)
MIL-L-2104C or MIL-L-46152	40	Above 10°F (12°C)
or API-SF or API-CD	30	Below 10°F (12°C)
Mineral Gear Oil with rust and oxidation inhibitor	90	Above 10°F (12°C)
API-GL-1	80W	Below 10°F (12°C)
Mild EP Gear Oil*	90	10°F to 100°F (12°C to 38°C)
MIL-L-2105 or API-GL-4	80W	-15°F to 70°F (-26°C to 21°C)
	85W144	Above 10°F (12°C)
Multipurpose Gear Oil*	80W140	Above -15°F (-26°C)
MIL-L-2105B or MIL-L-2105C	90	10°F to 100°F (12°C to 38°C)
or API-GL-5	80W90	-15°F to 100°F (-26°C to 38°C)
	80W	-15°F to 70°F (-26°C to 21°C)
	75W	-40°F to 15°F (-40°C to 26°C)

* Mild EP gear oil or multi-purpose gear oil are not recommended when lubricant operating temperatures are above 230°F (110°C).

Figure 13-3. Lubricant Chart.

TRANSMISSION REMOVAL

1. Drain the lubricant from the transmission.

2. Disconnect the selector rod from the shift lever and from the pivot link rod by removing cotter keys and nuts. Refer to figure 13-4. Do not disconnect the linkage at the turnbuckle which connects the selector lever to the linkage; doing so will result in misadjustment of the linkage.

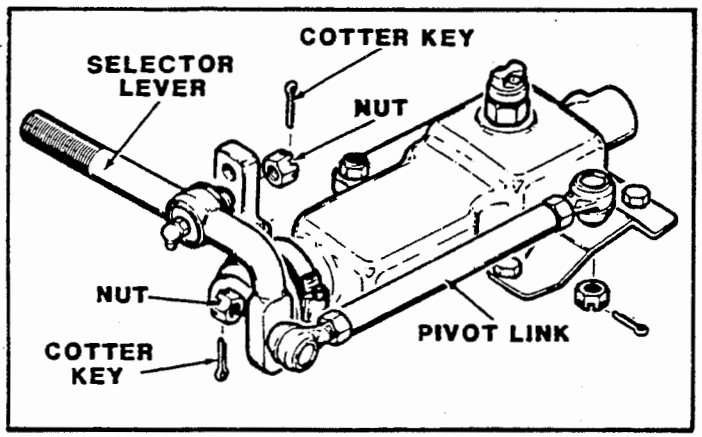


Figure 13-4. Disconnecting Shift Link.

3. Disconnect the external linkage from the clutch release arm to permit the release yoke to turn up and pull free of the bearing thrust pads.

4. A suitable sling or transmission jack should be used to properly maintain engine-transmission alignment when removing or installing the transmission. A transmission dolly is available through parts outlets or may be fabricated as shown on drawing 20-233. See Service Tools at end of this section.

CAUTION: Do not allow the rear of the transmission to drop down and hang unsupported in the splined hubs of the clutch discs. Failure to observe this caution will result in bending or distortion of the clutch friction discs.

5. Remove the mounting bolts and slide transmission on dolly away from engine while maintaining alignment.

DISASSEMBLY

Listed below are several disassembly techniques and procedures which will help the process go smoothly and help the overhaul to be successful.

1. Carefully wash and relubricate all reusable bearings as removed and protectively wrap until ready for use. Remove bearings planned to be reused with pullers designed for this purpose.

2. When disassembling the various assemblies, such as the mainshaft, countershafts, and shift bar housing, *lay all parts on a clean bench in the same sequence as removed. This procedure will simplify reassembly and reduce the possibility of losing parts.*

3. Remove snap rings with pliers designed for this purpose. Snap rings removed in this manner can be reused.

4. The input shaft can be removed from transmission without removing the countershafts, mainshaft, or drive gear. Special procedures are required. Refer to later page in this section for those procedures.

5. Provide yourself with a clean place to work. It is important that no dirt or foreign material enters the unit during repairs. Dirt is an abrasive and can damage bearings. It is always good practice to clean the outside of the unit before starting the planned disassembly.

6. Use restraint when applying force to shafts, housings, etc. Movement of some parts is restricted. Never apply force to the part being driven after it stops solidly. The use of soft hammers, bars and mauls for all disassembly work is recommended.

REMOVAL OF REMOTE CONTROL HOUSING

1. Turn out the two capscrews (13) and remove nuts (12) from the two studs (figure 13-5).

2. Lift the remote control housing from the shift bar housing.

MC-9 MAINTENANCE MANUAL

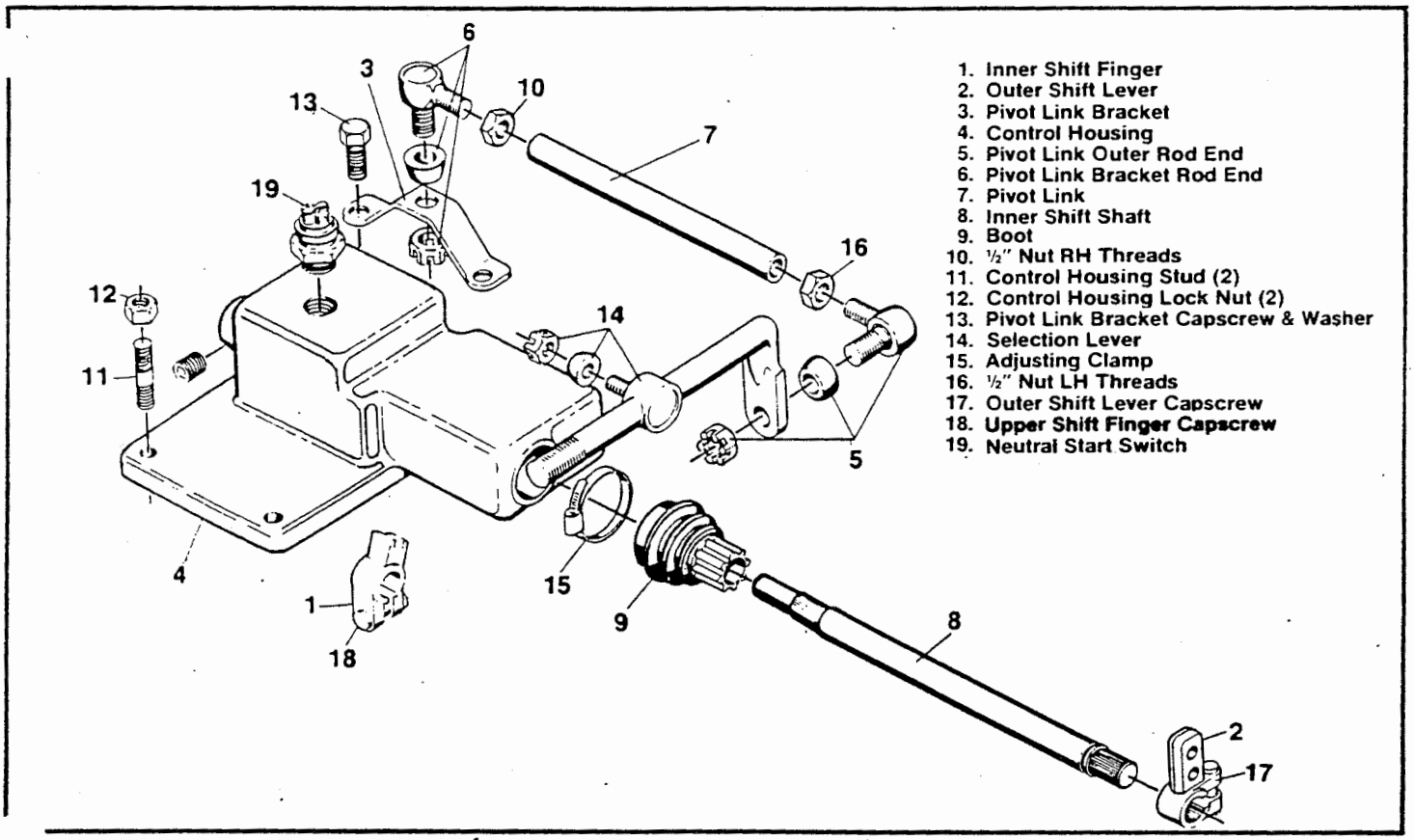

1. Inner Shift Finger
2. Outer Shift Lever
3. Pivot Link Bracket
4. Control Housing
5. Pivot Link Outer Rod End
6. Pivot Link Bracket Rod End
7. Pivot Link
8. Inner Shift Shaft
9. Boot
10. ½" Nut RH Threads
11. Control Housing Stud (2)
12. Control Housing Lock Nut (2)
13. Pivot Link Bracket Capscrew & Washer
14. Selection Lever
15. Adjusting Clamp
16. ½" Nut LH Threads
17. Outer Shift Lever Capscrew
18. Upper Shift Finger Capscrew
19. Neutral Start Switch

Figure 13-5. Remote Control Housing.

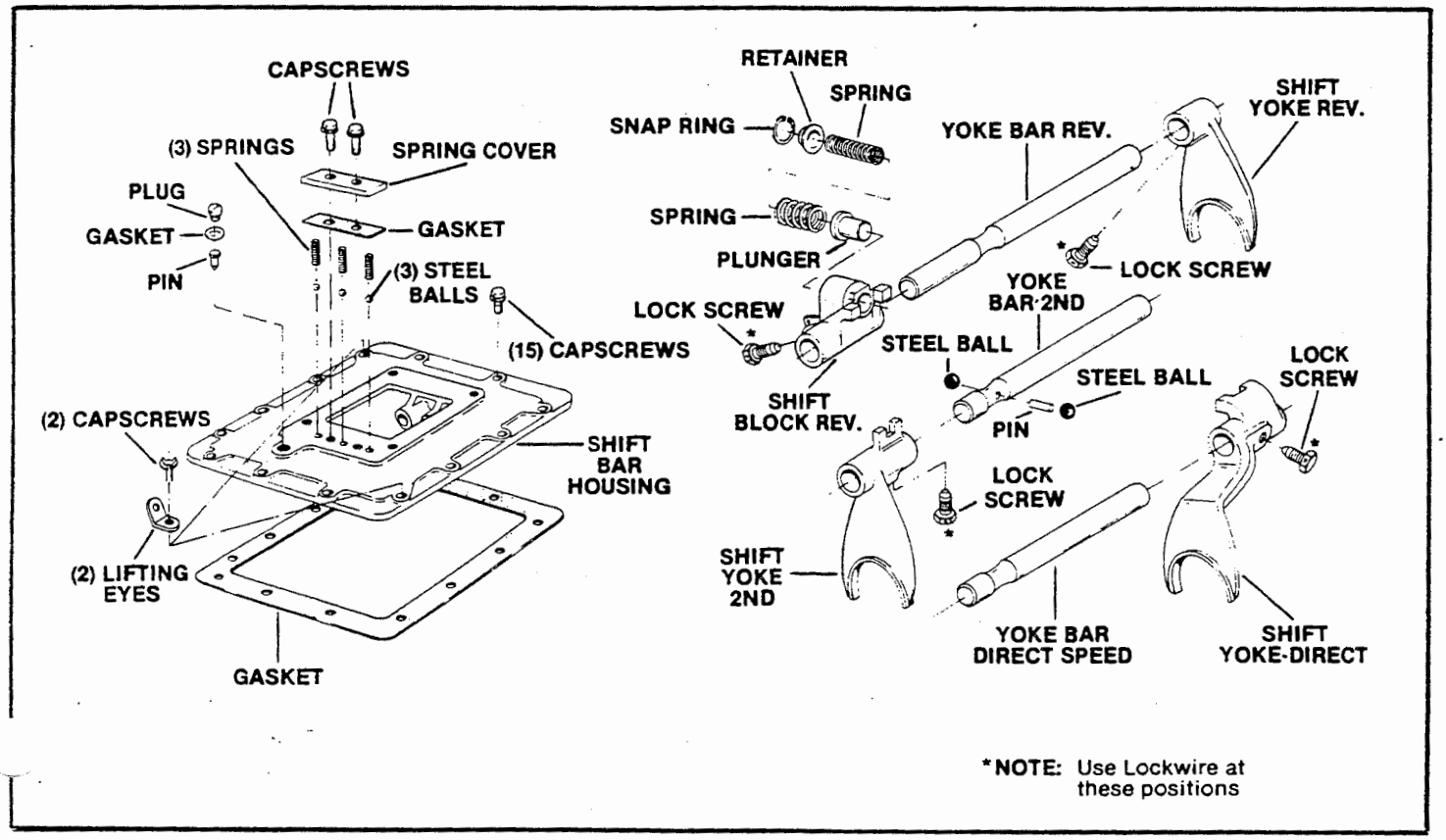


Figure 13-6. Shift Bar Housing.

MC-9 MAINTENANCE MANUAL

SHIFT BAR HOUSING REMOVAL AND DISASSEMBLY

1. Turn out the attaching capscrews (figure 13-7). Jar to break the gasket seal and lift the shift bar housing from the transmission (figure 13-8).

NOTE: Lay all parts on a clean bench in the order in which they are removed to facilitate reassembly. Keep bars not being removed in the neutral position or interlock parts will lock bars.

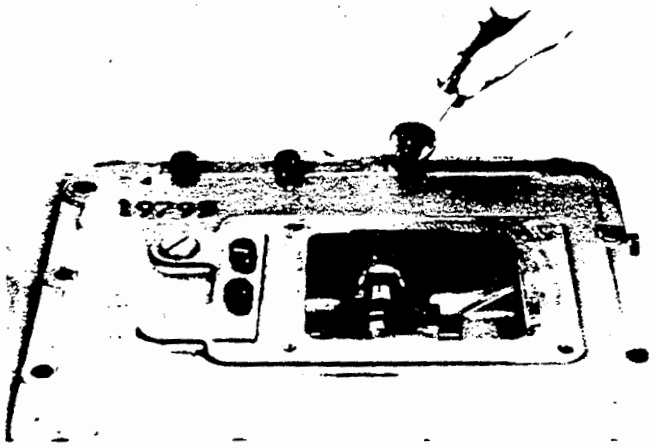


Figure 13-7. Removing Capscrews.

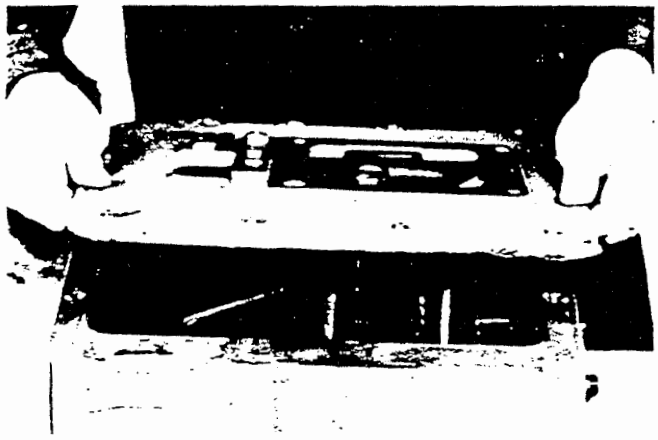


Figure 13-8. Removing Shift Bar Housing.

2. Turn out the two capscrews and remove the tension spring cover from top of housing.

3. Remove the three tension springs from bores in housing (figure 13-9) and the gasket for tension spring cover.

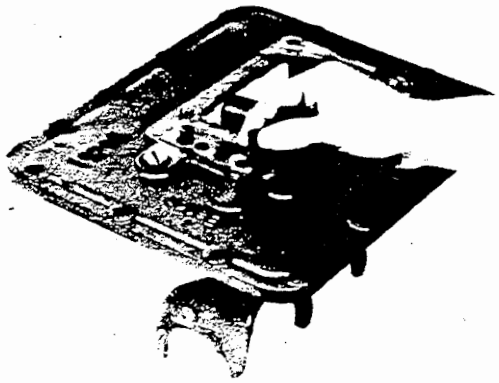


Figure 13-9. Tension Spring Removal.

4. Tilt housing and remove the tension balls installed under springs (figure 13-10).

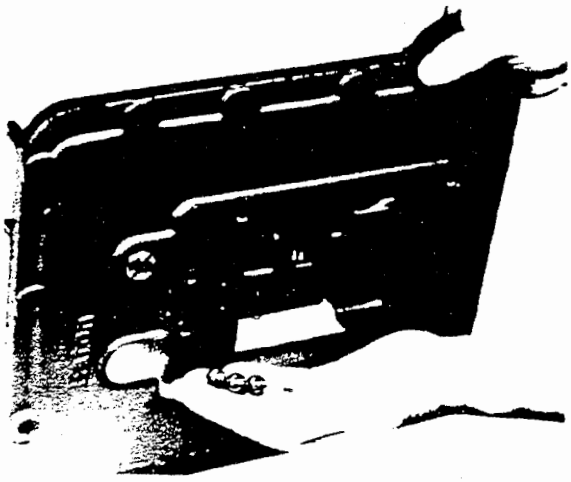


Figure 13-10. Removing Tension Balls.

5. Place the housing in a vise with the left side up; the long bar will be at the bottom (figure 13-11).

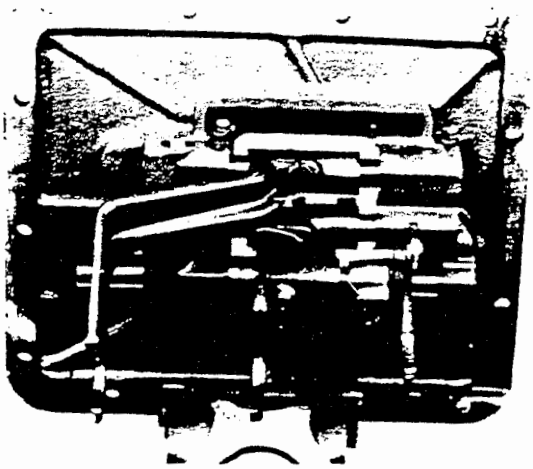


Figure 13-11. Positioning Housing In Vise.

6. Cut lockwire and remove lock screws from each bar just prior to its removal.

7. Move the top, 4th-5th speed shifting bar to the front and out of housing, removing shifting yoke from bar (figure 13-12).

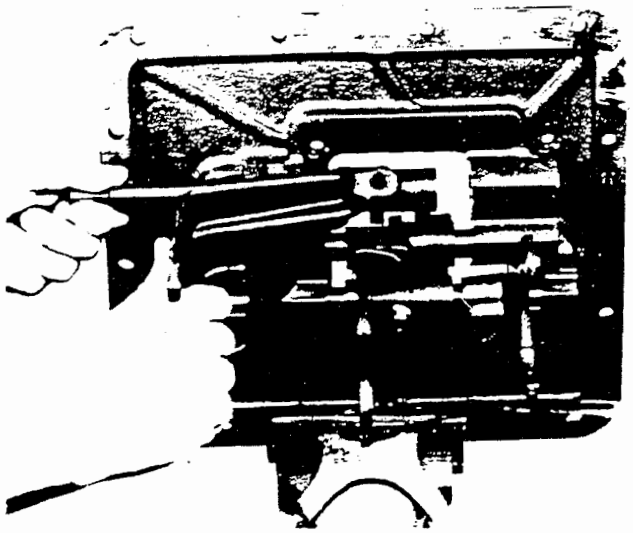


Figure 13-12. Top Shift Bar Removal.

8. Move the center, 2nd-3rd speed shifting bar to the front and out of housing, removing the shifting yoke from bar. As the neutral notch in bar clears housing boss, remove the small interlock pin from bore in neutral notch (figure 13-13).

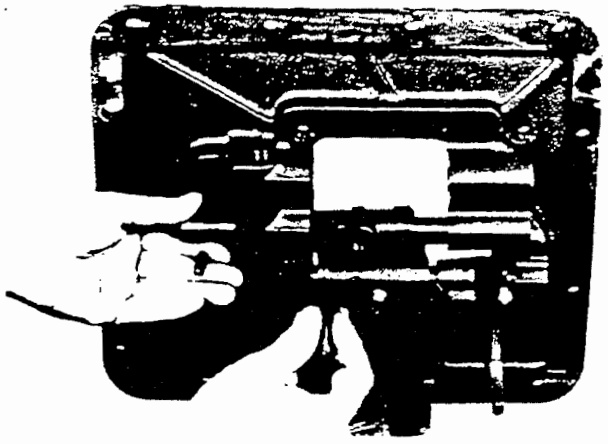


Figure 13-13. Removing Interlock Pin.

9. Move the bottom, 1st-reverse speed shifting bar to the front and out of housing, removing the shift yoke and block from the bar.

10. Two interlock balls will fall from interlock ball opening in front boss as the last bar is removed (figure 13-14).

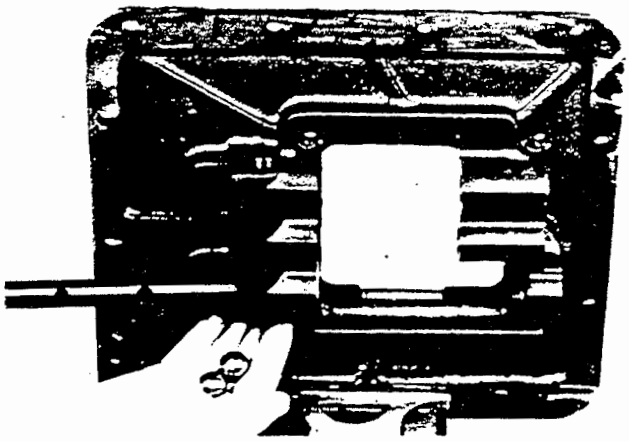


Figure 13-14. Released Interlock Balls.

MC-9 MAINTENANCE MANUAL

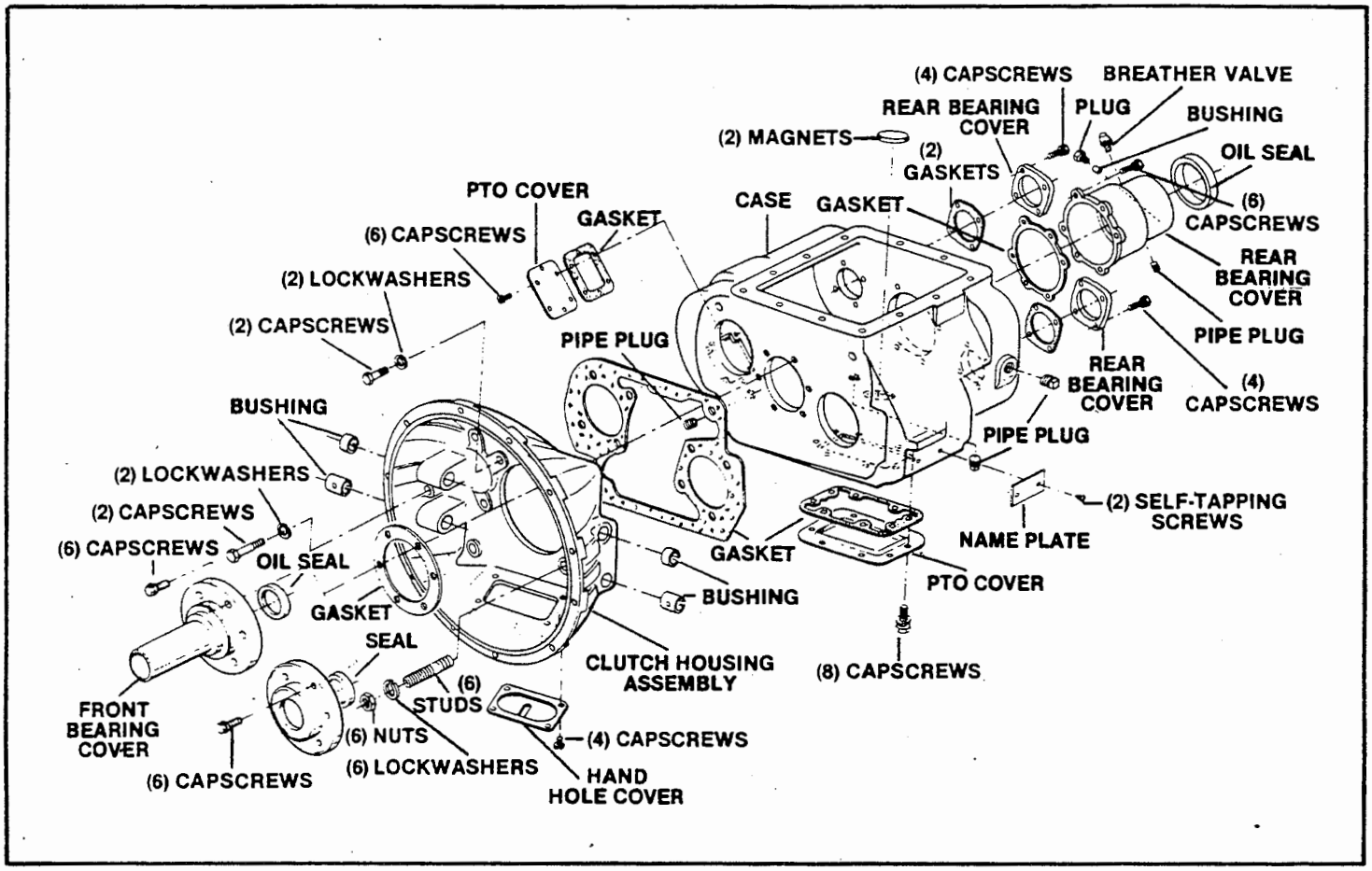


Figure 13-15. Speed Transmission Housing Assembly.

REMOVAL OF COMPANION FLANGE (OR END YOKE) AND REAR BEARING COVER

1 Lock the mainshaft by engaging two speeds with the mainshaft sliding clutch gears.

2. Remove the elastic stop nut from the output shaft (figure 13-16).

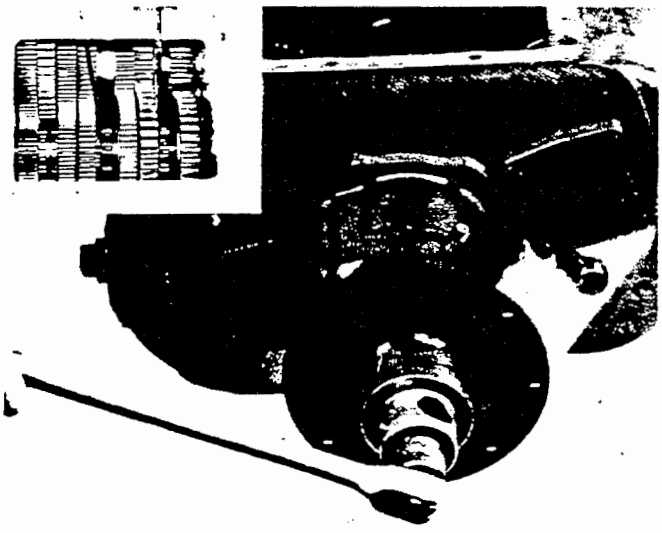


Figure 13-16. Stop Nut Removal.

3. Pull the flange or yoke from splines of the output shaft.

4. Turn out the attaching capscrews from the rear bearing cover.

5. Pry the bearing cover evenly to the rear to unseat from output shaft bearing (figure 13-17).

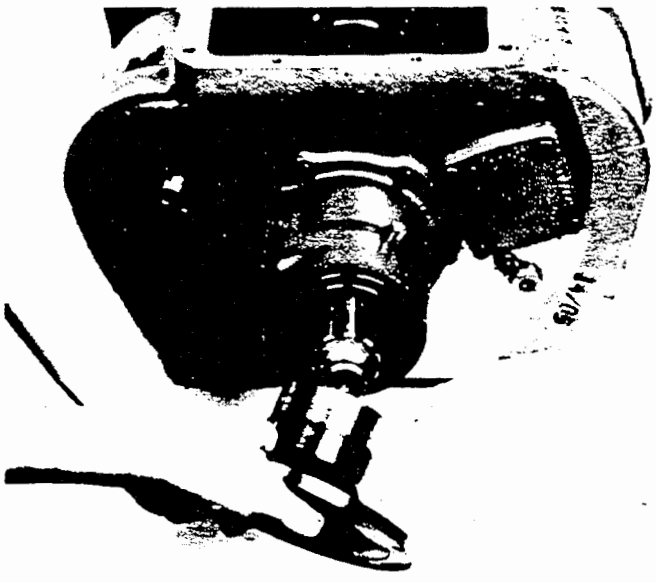


Figure 13-17. Pry Bearing Cover Evenly.

MC-9 MAINTENANCE MANUAL

6. Remove the bearing cover from output shaft (figure 13-18).

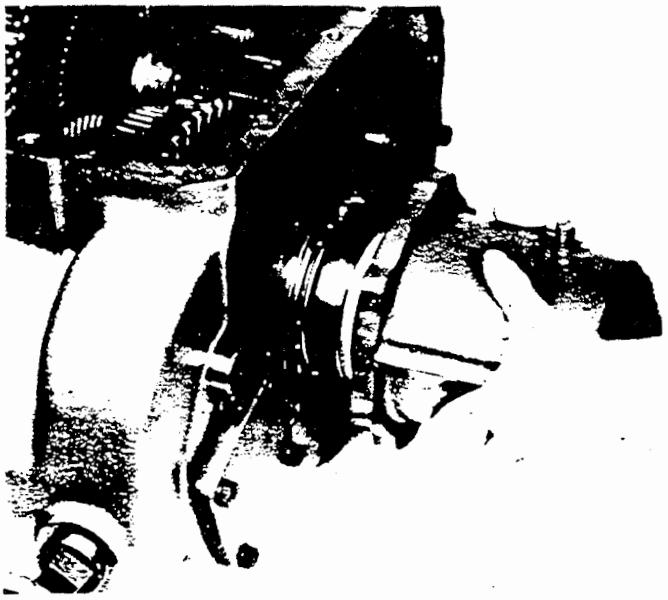


Figure 13-18. Bearing Cover Removal.

OUTPUT SHAFT REMOVAL - refer to figure 13-20

1. Remove the spacer and the bearing washer from output shaft or from bearing cover (figure 13-19).

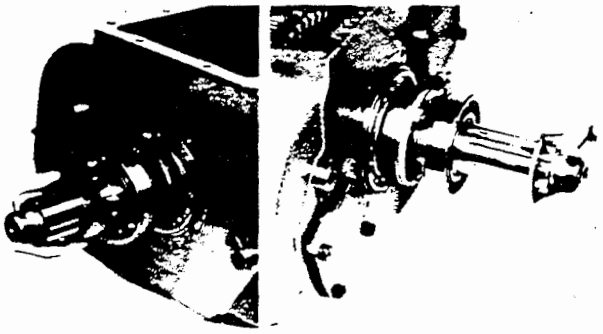


Figure 13-19. Spacer and Washer Removal.

2. Remove the oil seal from cover if necessary (figure 13-21).

NOTE: This bearing may remain in cover; in this case, move the bearing evenly forward and from cover.

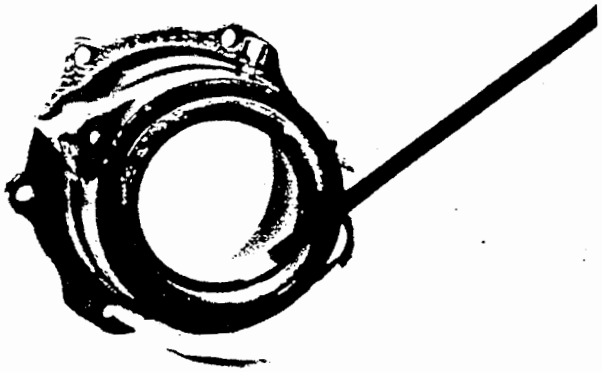


Figure 13-21. Removing Oil Seal From Cover.

3. Pull the outer bearing from output shaft (figure 13-22).

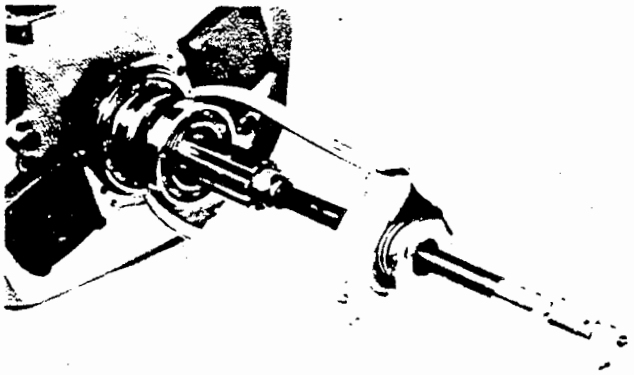


Figure 13-22. Pulling Outer Bearing.

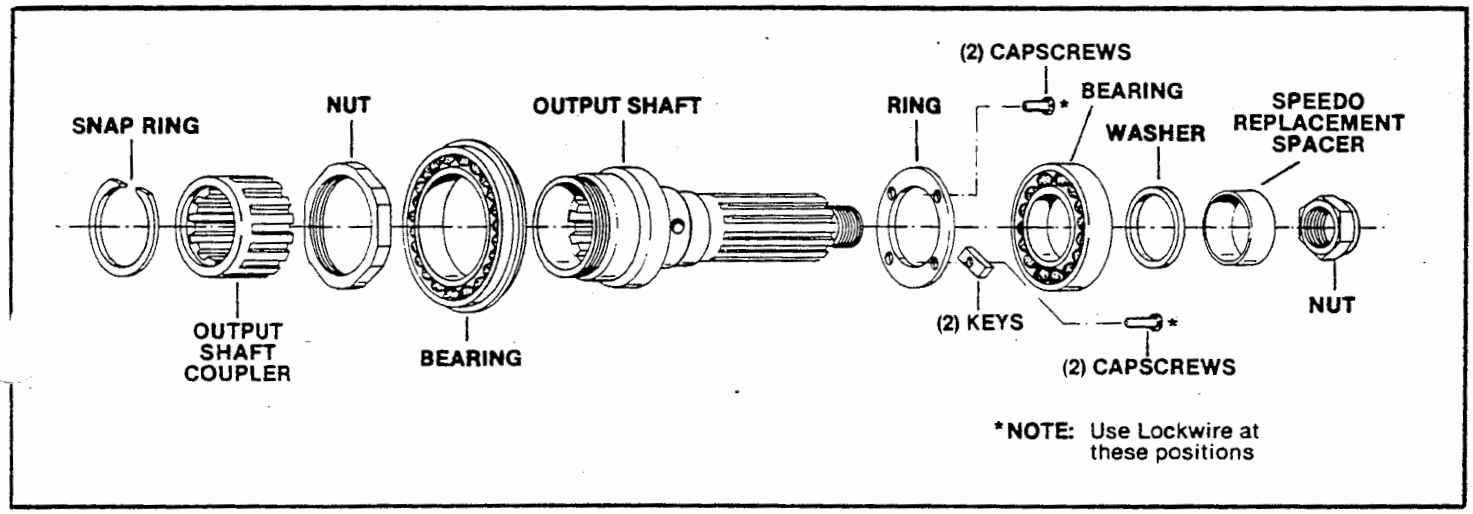


Figure 13-20. Output Shaft Assembly.

4. Cut lockwire and remove the two 5/16" capscrews from the two flat keys (figure 13-23).



Figure 13-23. Removing Capscrews.

5. Remove the two flat keys from bores in output shaft. These keys maintain the position of the mainshaft in relation to output shaft (figure 13-24).

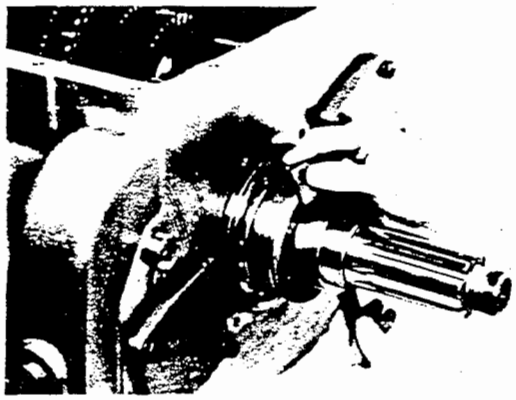


Figure 13-24. Removing Keys.

6. Move the output shaft evenly to the rear and from case bore. Moving the mainshaft assembly to the rear will start moving output shaft from bore (figure 13-25).

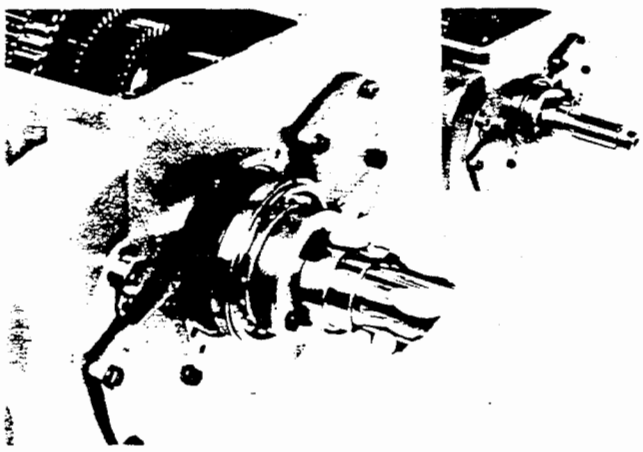


Figure 13-25. Output Shaft Removal.

7. Remove the splined coupling gear from mainshaft, or from pocket in output shaft (figure 13-26).

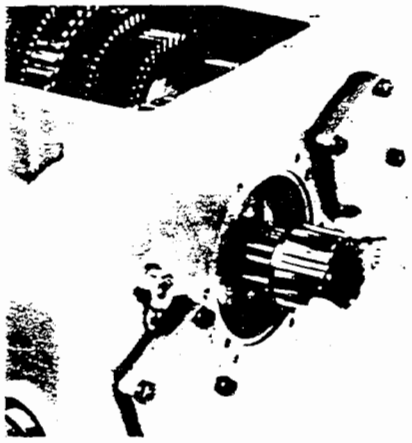


Figure 13-26. Removing Splined Coupling Gear.

8. Turn out the two 5/16" capscrews and remove the key spacer ring from output shaft (figure 13-27).



Figure 13-27. Removing Spacer Ring.

9. Remove the bearing nut from the output shaft, left hand thread (figure 13-28).

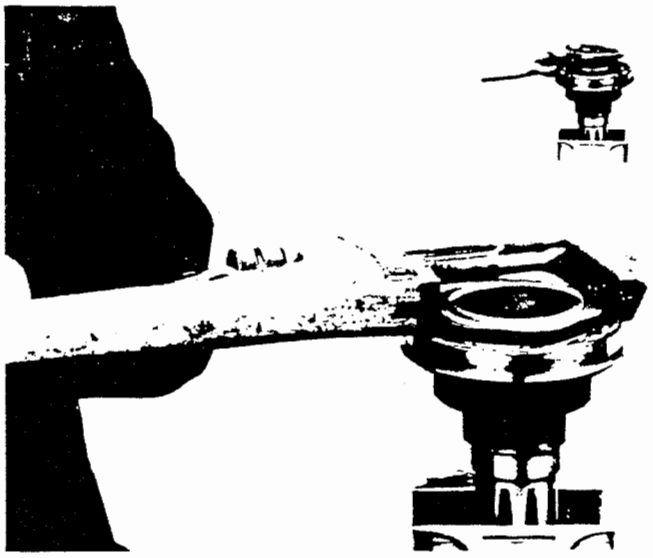


Figure 13-28. Bearing Nut Removal.

10. Press the front bearing from output shaft (figure 13-29).

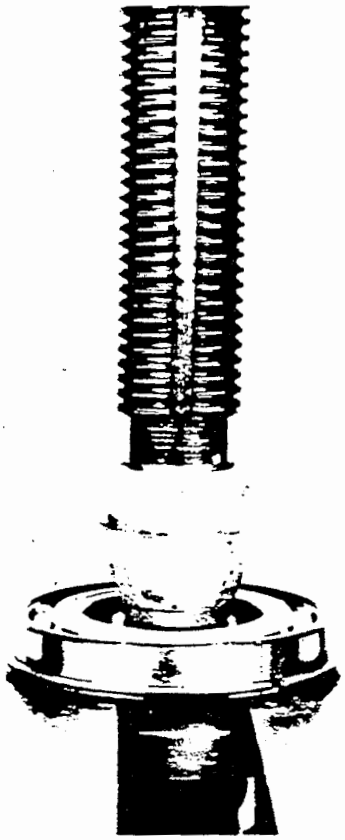


Figure 13-29. Pressing Out Bearing.

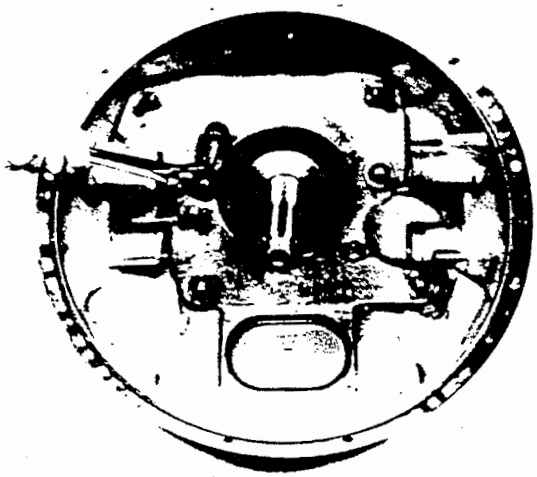


Figure 13-30. Removing Nuts from Studs.

CLUTCH HOUSING REMOVAL

NOTE: The clutch housing can be removed at any time during transmission disassembly. However, it must be removed before the two countershafts can be removed.

1. Remove the clutch release mechanism.

2. Remove the four bolts and remove the six nuts and lock washers from studs at front of case (figure 13-30).

3. Break gasket seal and pull clutch housing from case (figure 13-31).

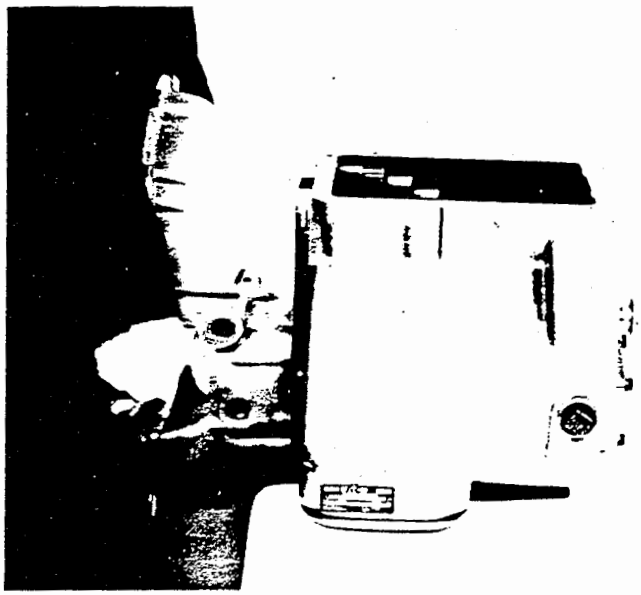


Figure 13-31. Pulling Clutch Housing from Transmission Case.

MC-9 MAINTENANCE MANUAL

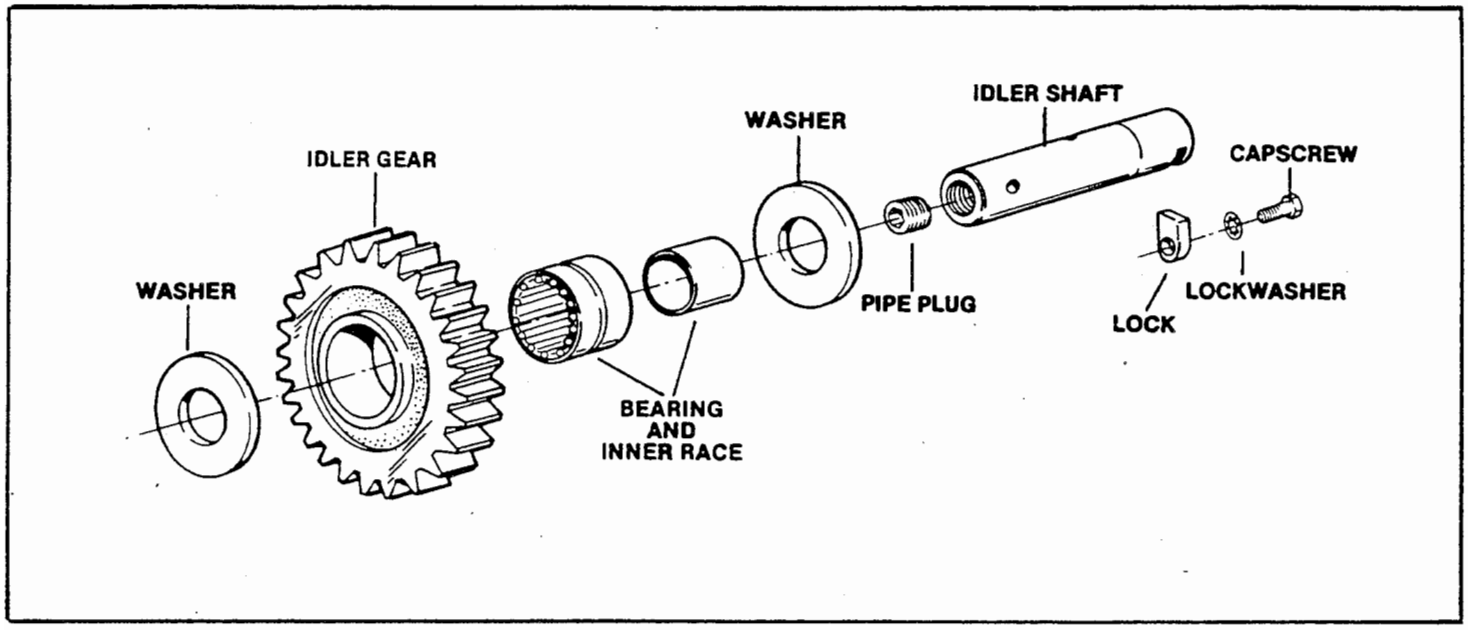


Figure 13-32. Reverse Idler Shaft Assembly.

LEFT REVERSE IDLER GEAR REMOVAL

NOTE: The left reverse idler gear must be removed in order to remove the mainshaft assembly. (See figure 13-32 for assembly drawing.)

1. Move the mainshaft assembly forward as far as possible and the mainshaft reverse gear to the rear against case (figure 13-33).

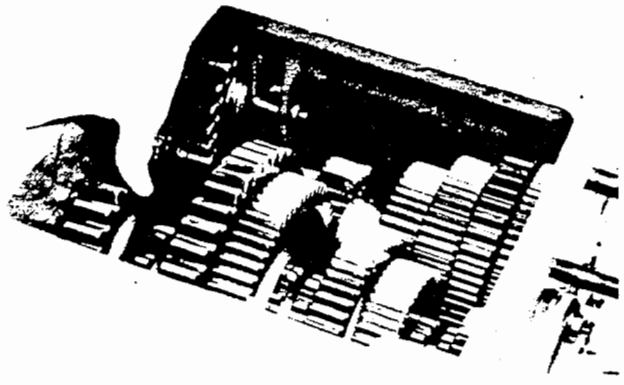


Figure 13-33. Moving Mainshaft Assembly.

2. Remove the retaining ring from I.D. of the mainshaft reverse gear (figure 13-34).

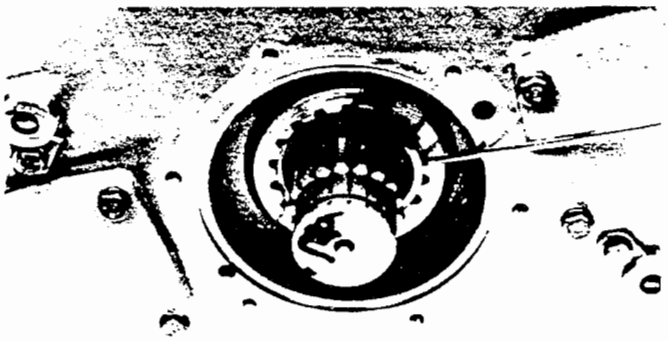


Figure 13-34. Removing Retaining Ring.

3. Engage reverse gear with the 1st-reverse sliding clutch and move the reverse gear forward against the 1st speed gear (figure 13-35).



Figure 13-35. Moving Reverse Gear and Reverse Clutch.

4. Remove capscrew at rear of transmission and remove the lock plate from slot in the idler shaft (figure 13-36).

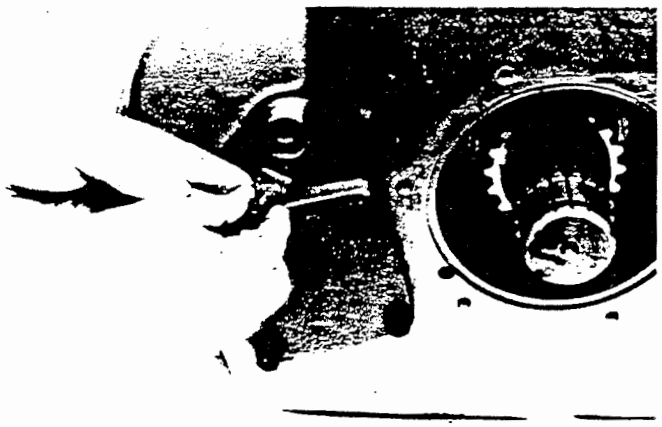


Figure 13-36. Removing Lock Plate.

5. Use impact puller to withdraw the idler shaft from case (figure 13-37).

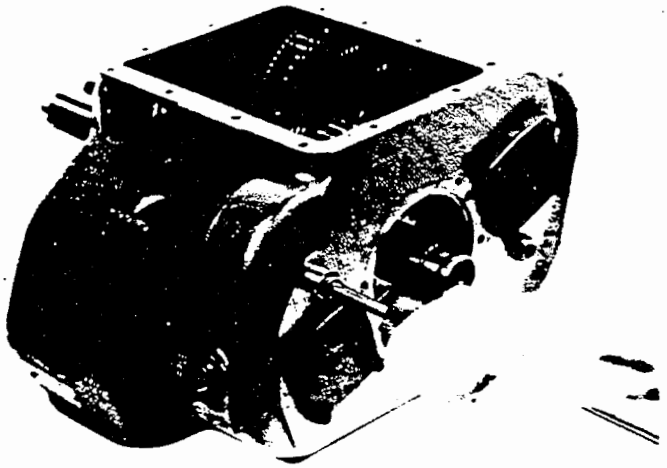


Figure 13-37. Withdrawing Idler Shaft.

6. Remove the reverse idler gear and the two thrust washers from case (figure 13-38).



Figure 13-38. Idler Gear Removal.

7. Remove inner race of bearing from gear bore (figure 13-39).

8. Press the needle bearing from gear bore (figure 13-39).

9. Remove plug from idler shaft if necessary (figure 13-39).

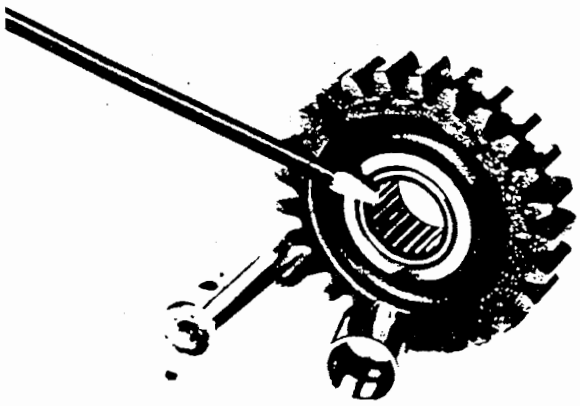


Figure 13-39. Reverse Idler Gear Disassembled.

REMOVAL OF COUNTERSHAFT BEARINGS

NOTE: Although the bearings of both countershafts are removed in the same manner, it is necessary to remove the bearings from only the right countershaft to remove the mainshaft assembly from case.

1. Remove capscrews and the rear bearing cover and gasket from each countershaft (figure 13-40).

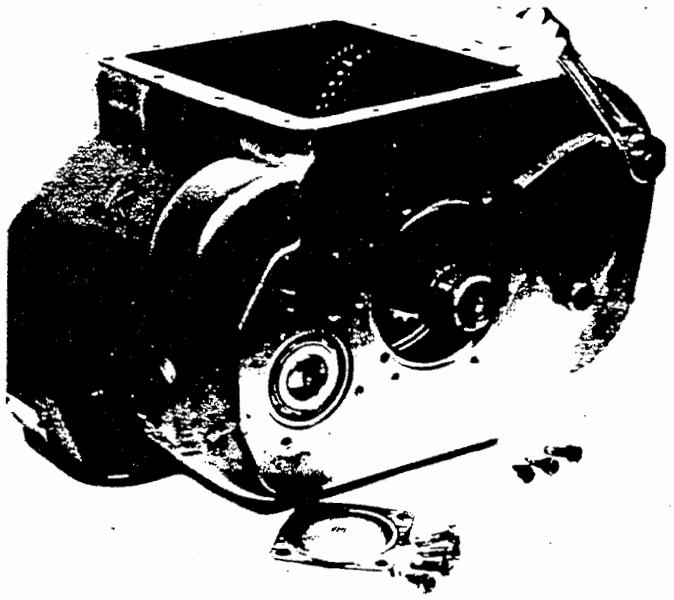


Figure 13-40. Removing Bearing Covers.

2. Use a soft punch and maul from inside case to drive the rear countershaft bearings to the rear and from case bores (figure 13-41).

CAUTION: This removal procedure will damage the bearings and should not be attempted unless bearings are being replaced.

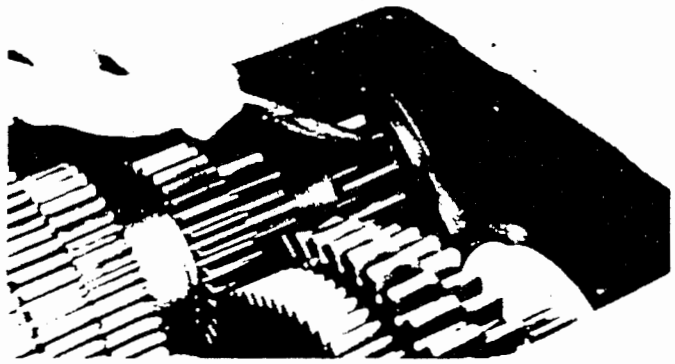


Figure 13-41. Driving Out Countershaft Bearings.

3. Cut lockwire and remove the two capscrews and retainer plate from the front of each countershaft. For models equipped with bearing retaining rings in groove of countershafts, remove retaining ring from groove in both countershafts (figure 13-42).

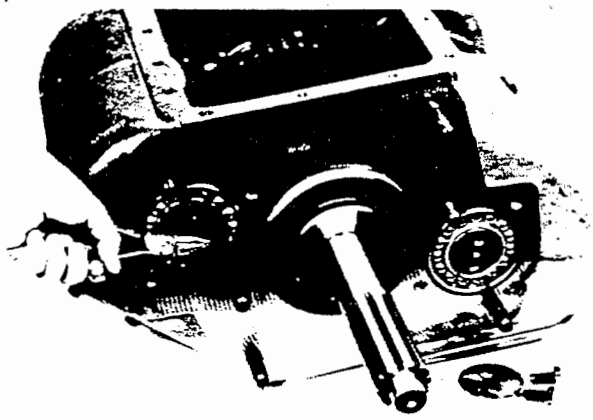


Figure 13-42. Retaining Ring Removal.

4. Use a soft bar and maul to drive each countershaft to the rear approximately ½" (figure 13-43).

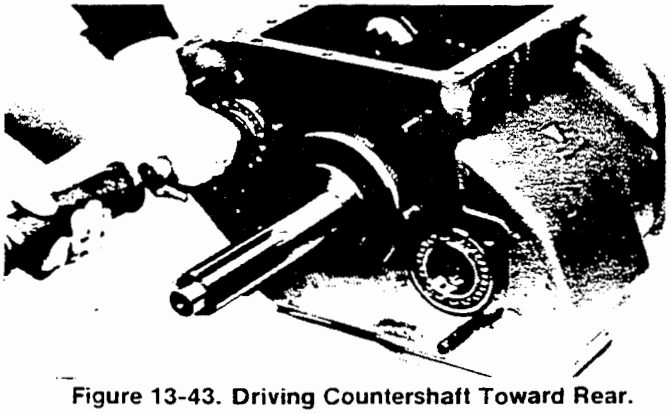


Figure 13-43. Driving Countershaft Toward Rear.

5. With the same soft bar and maul on the rear of each countershaft, drive the countershafts forward to expose the front bearing retaining rings (figure 13-44). Remove the retaining rings.

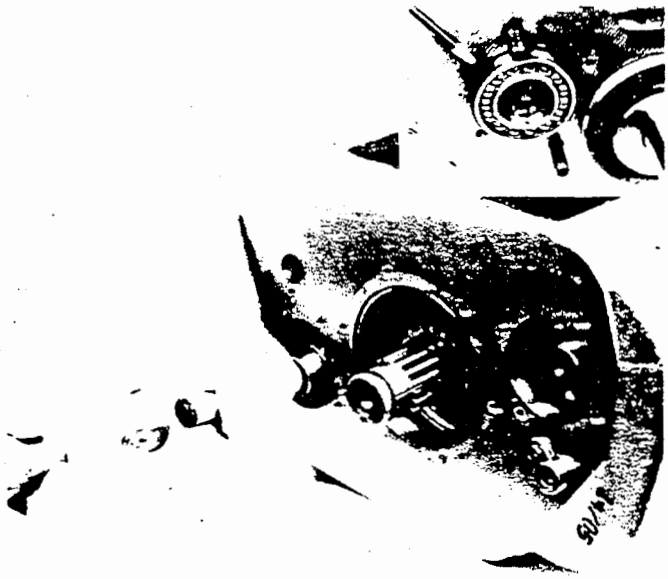


Figure 13-44. Driving Countershaft Forward.

6. Use a bearing puller to remove the front bearing from each countershaft (figure 13-45).

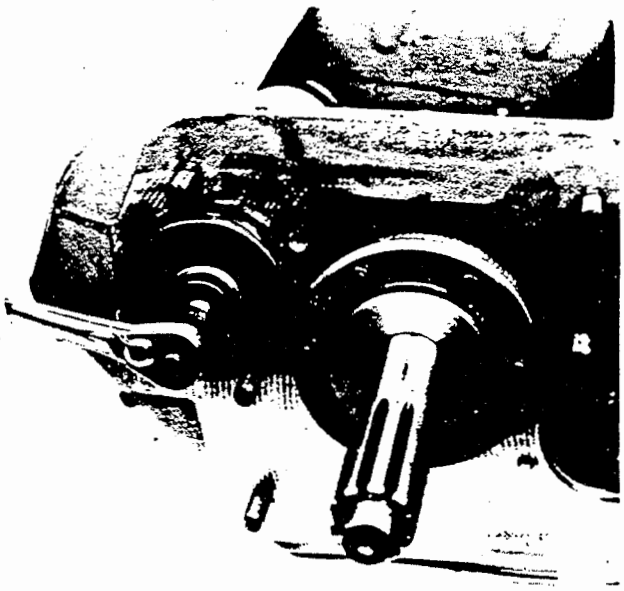


Figure 13-45. Bearing Removal.

MC-9 MAINTENANCE MANUAL

NSHAFT REMOVAL AND DISASSEMBLY
(Refer to figure 13-46)

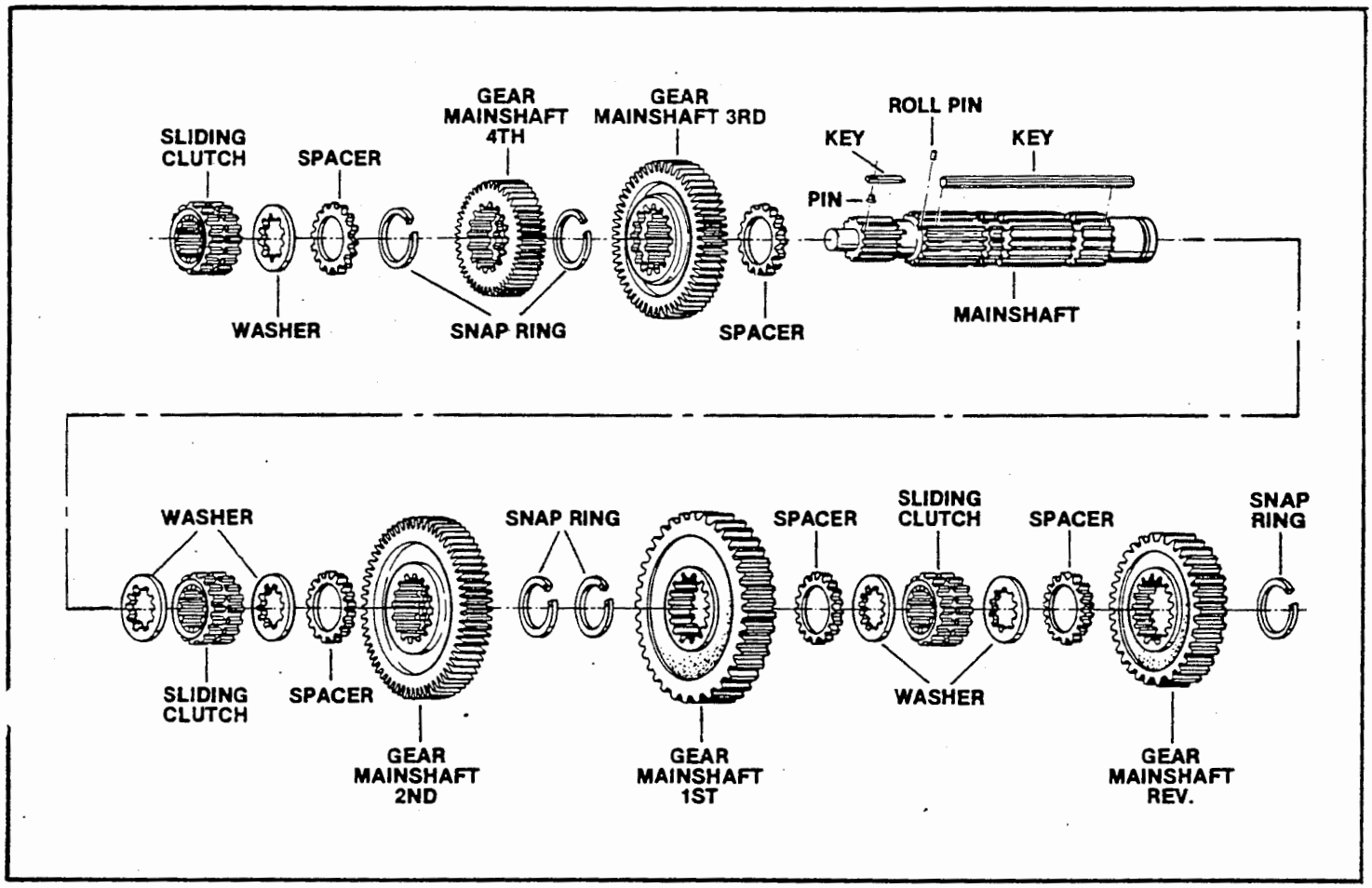


Figure 13-46. Mainshaft and Related Gears.

1. With the right countershaft moved toward wall of case, pull the mainshaft to the rear to free pilot from pocket of drive gear shaft (figure 13-47).

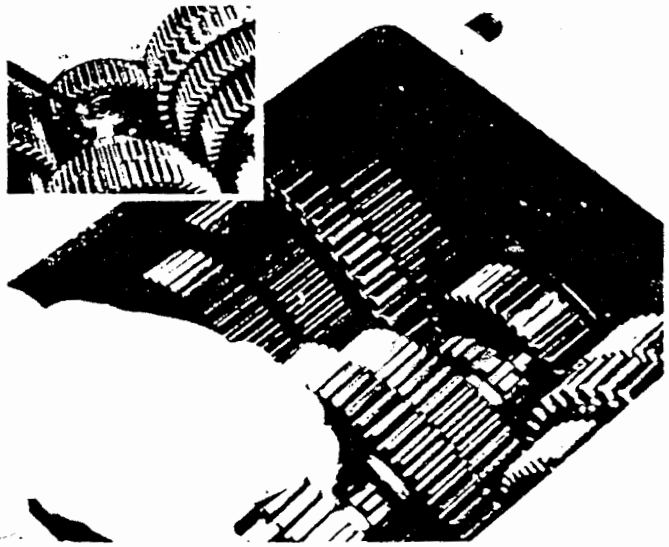


Figure 13-47. Freeing Pilot From Drive Gear Shaft Pocket.

2. While holding 3rd and 4th speed gears, tilt the front of the mainshaft up and lift assembly from case (figure 13-48).

CAUTION: The reverse gear is free at this point and may fall from shaft.

NOTE: When removing washers, spacers and gears, note their location to facilitate reassembly. Refer to figure 13-46. Keep washers and spacers with the gear from which they were removed; there is one spacer and one washer for each gear. The spacers have external splines to engage gear splines; the washers have internal splines to engage mainshaft splines.

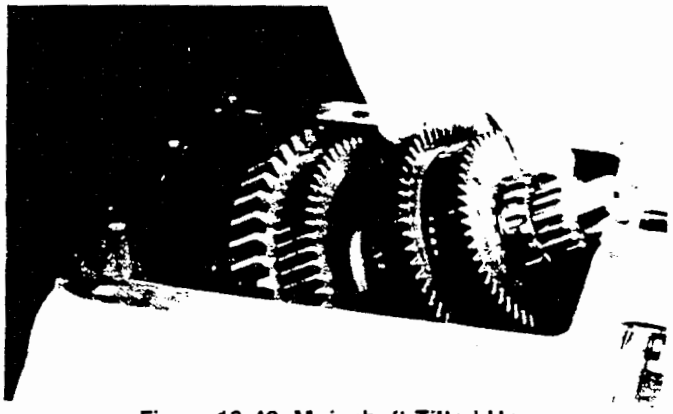


Figure 13-48. Mainshaft Tilted Up.

3. Remove the reverse gear from mainshaft (figure 13-49).

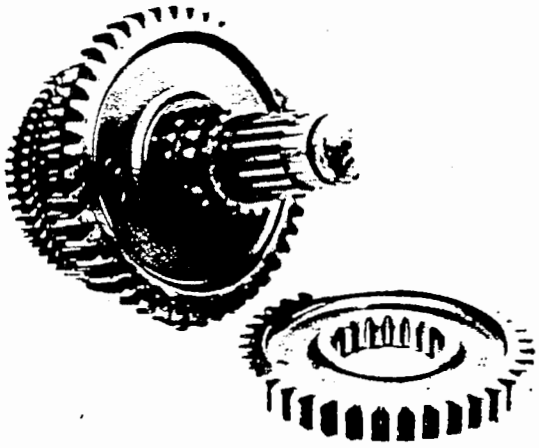


Figure 13-49. Removing Gear From Rear of Mainshaft.

4. Remove the 4th-5th speed sliding clutch from front of shaft (figure 13-50).

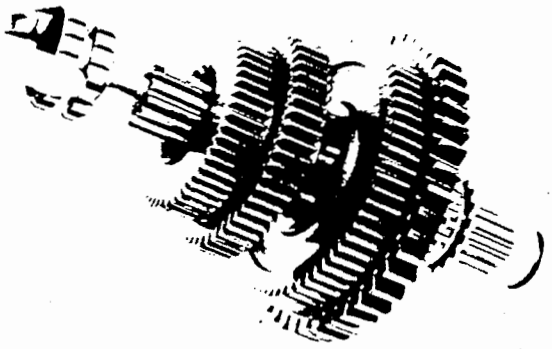


Figure 13-50. Removing 4th-5th Speed Clutch.

5. Remove the short key from keyway near front of shaft. This key locks the fourth speed gear limit washer in position (figure 13-51).

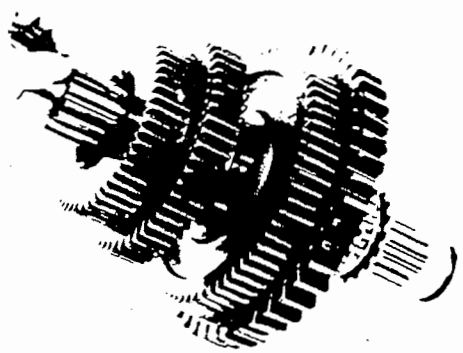


Figure 13-51. Removing Key.

6. Turn the 4th speed gear washer, located in hub of 4th-speed gear, to align with splines in mainshaft (figure 13-52).

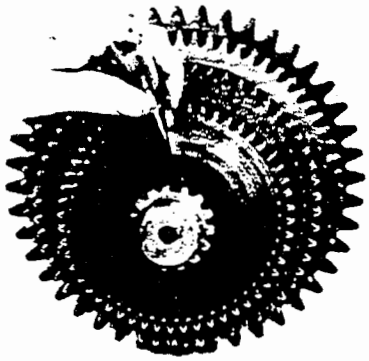


Figure 13-52. Washer Alignment.

7. Pull 4th speed gear forward to remove the washer, spacer and gear from mainshaft (figure 13-53).

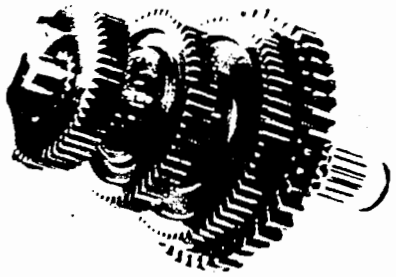


Figure 13-53. Removing 4th Speed Gear.

8. Remove the 3rd speed gear and spacer from front of mainshaft. The 3rd speed gear limit washer cannot be removed at this time as it is keyed in groove of mainshaft (figure 13-54).

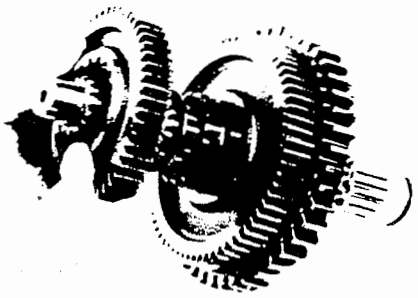


Figure 13-54. Removing 3rd Speed Gear and Spacer.

MC-9 MAINTENANCE MANUAL

9. Remove the long key retaining snap ring from slot near rear of mainshaft (figure 13-55).

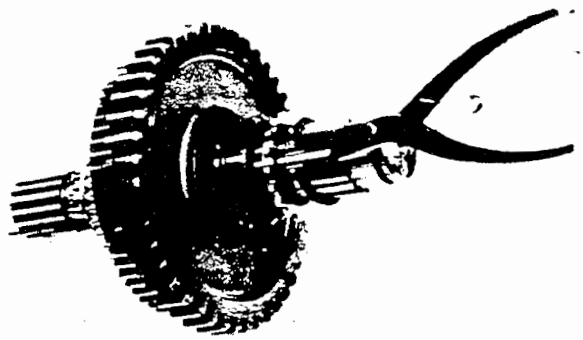


Figure 13-55. Retaining Ring Removal.

10. Remove the reverse gear spacer (figure 13-56).

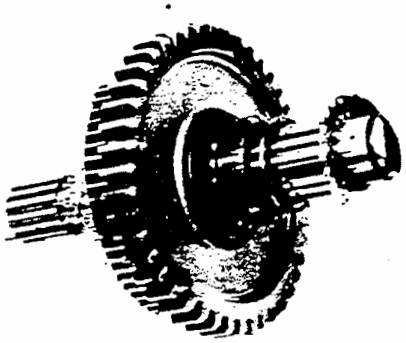


Figure 13-56. Removing Reverse Gear Spacer.

11. Pull the long key from mainshaft (figure 13-57).

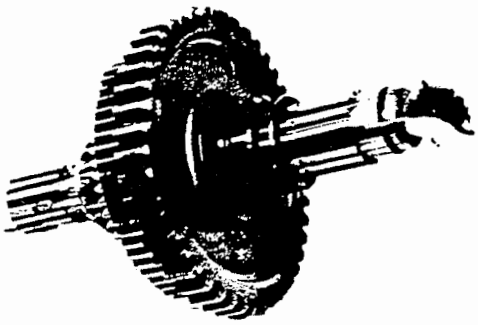


Figure 13-57. Long Key Removal.

12. Rotate reverse gear limit washer to align its splines with those of the mainshaft and remove washer (figure 13-58).

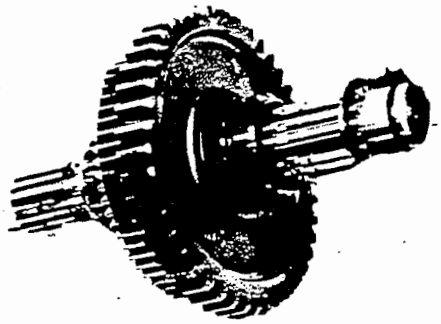


Figure 13-58. Removing Limit Washer.

13. Remove 1st-reverse sliding clutch from mainshaft (figure 13-59).

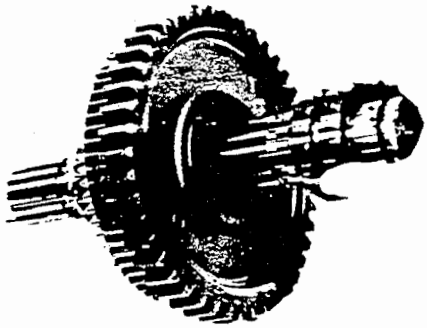


Figure 13-59. Removing 1st Reverse Sliding Clutch.

14. With a small screwdriver, rotate the 1st speed gear limit washer, recessed within the gear hub, to align its splines with those of the mainshaft (figure 13-60).

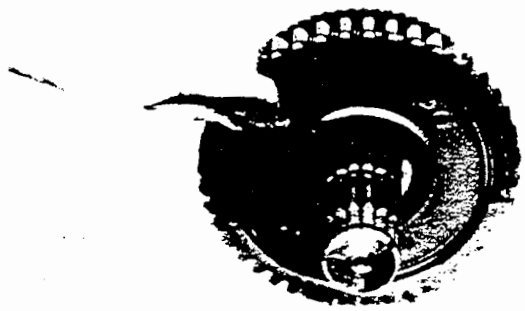


Figure 13-60. Aligning Washer Splines.

15. Pull the 1st speed gear from rear of mainshaft to remove limit washer, spacer, and gear (figure 13-61).

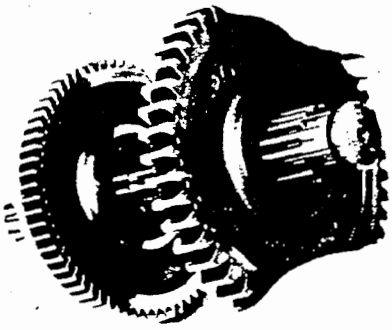


Figure 13-61. Removing 1st Speed Gear, Limit Washer and Spacer.

16. Remove 2nd speed gear and spacer from mainshaft (figure 13-62).

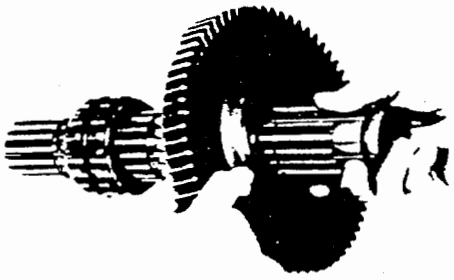


Figure 13-62. Removing 2nd Speed Gear and Spacer.

17. Rotate 2nd speed gear limit washer to align its splines with those of the mainshaft and remove washer (figure 13-63).

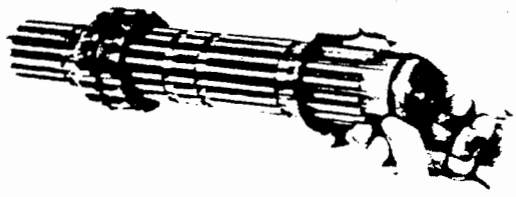


Figure 13-63. Removing 2nd Speed Gear Limit Washer.

18. Remove the 2nd-3rd speed sliding clutch from mainshaft (figure 13-64).

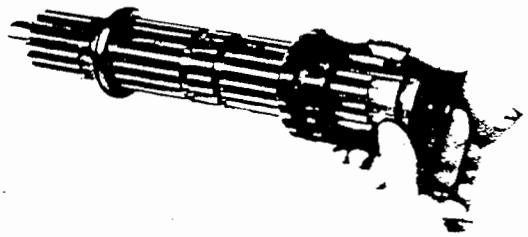


Figure 13-64. Removing 2nd-3rd Speed Sliding Clutch.

19. Rotate 3rd speed gear limit washer to align its splines with those of mainshaft and remove washer (figure 13-65).

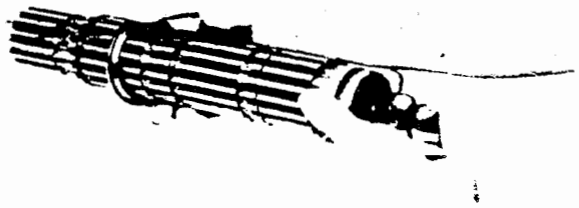


Figure 13-65. Removing 3rd Speed Gear Limit Washer.

Mainshaft disassembly (figure 13-46) is now complete.

MC-9 MAINTENANCE MANUAL

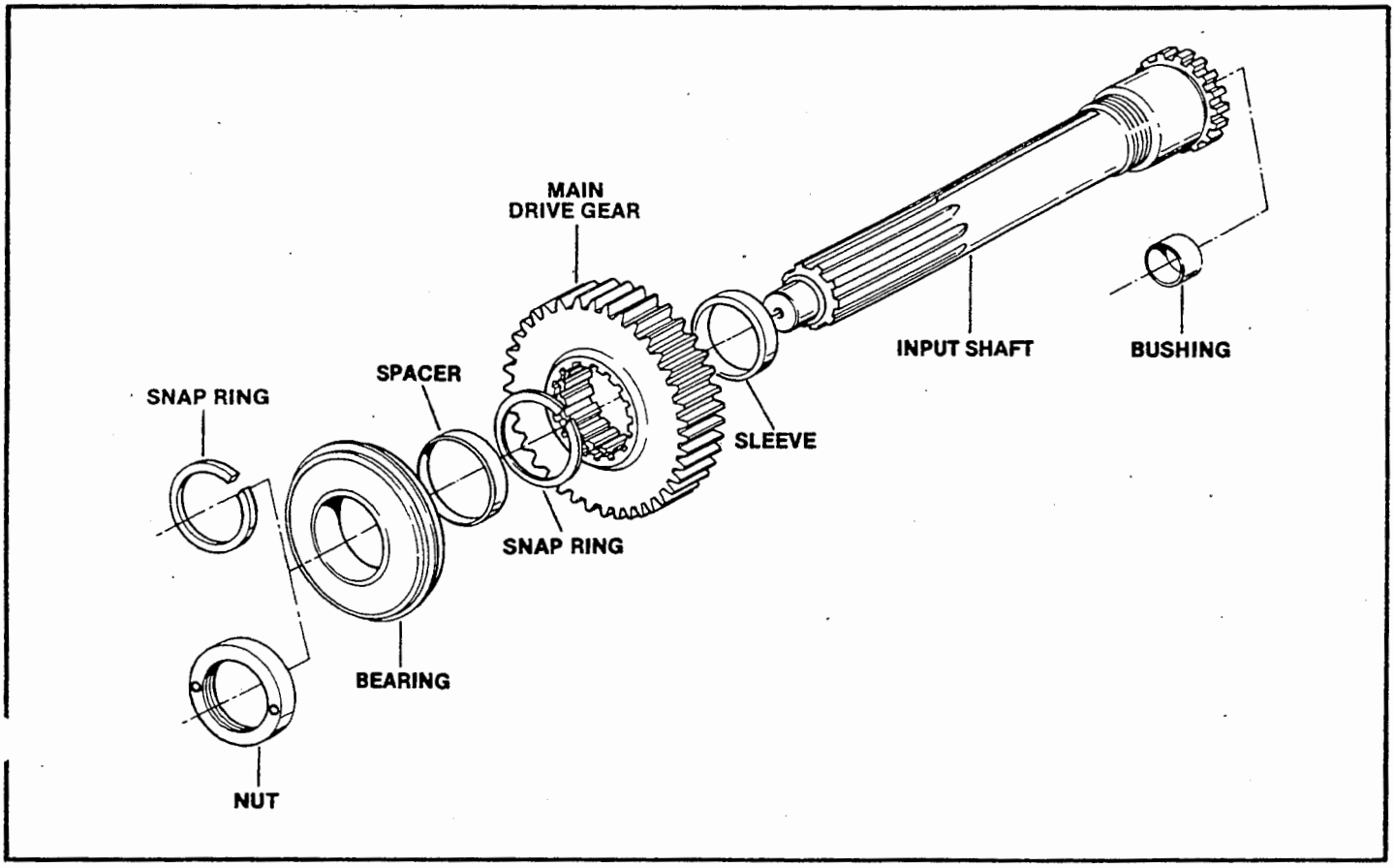


Figure 13-66. Drive Shaft (Input Shaft) and Related Parts.

DRIVE GEAR REMOVAL

1. (See figure 13-66 for assembly drawing.) Remove capscrews from the front bearing cover (figure 13-67).

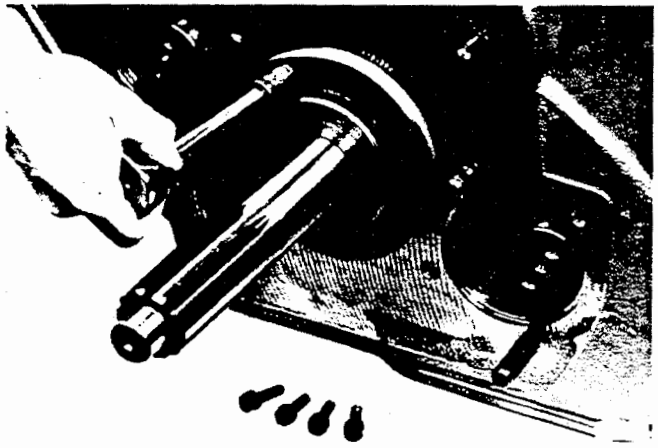


Figure 13-67. Capscrew Removal.

2. Use soft bar and maul from inside case to move the drive gear assembly forward as far as possible and remove the bearing cover (figure 13-68).



Figure 13-68. Moving Drive Gear Forward.

MC-9 MAINTENANCE MANUAL

3. Remove the retaining ring from front bearing (figure 13-69).

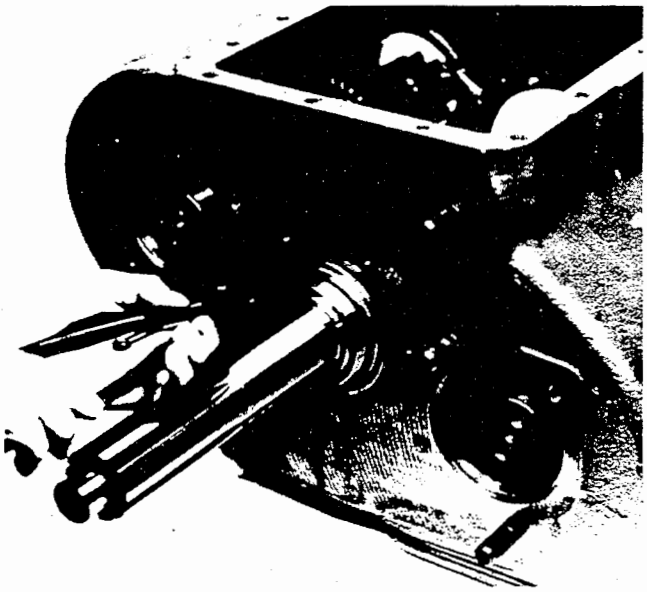


Figure 13-69. Removing Retaining Ring.

4. Use a soft maul, rubber or rawhide mallet to move input shaft into case, being careful not to damage pilot-end (figure 13-70).

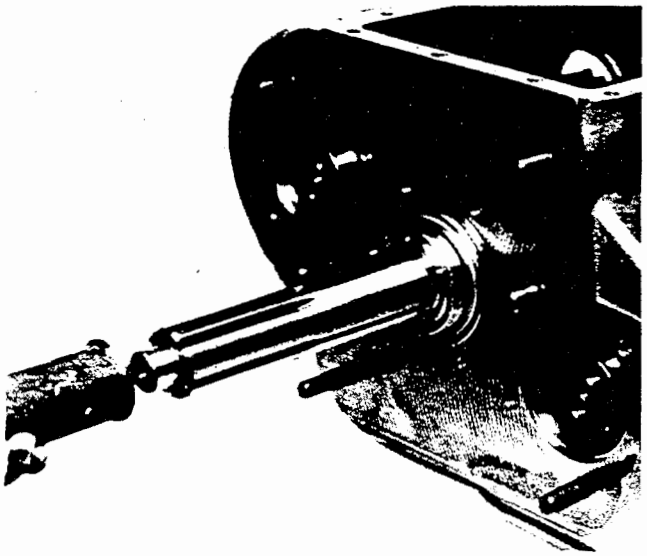


Figure 13-70. Moving Input Shaft Into Case.

5. Remove drive gear assembly from transmission by lifting it out through top of case.

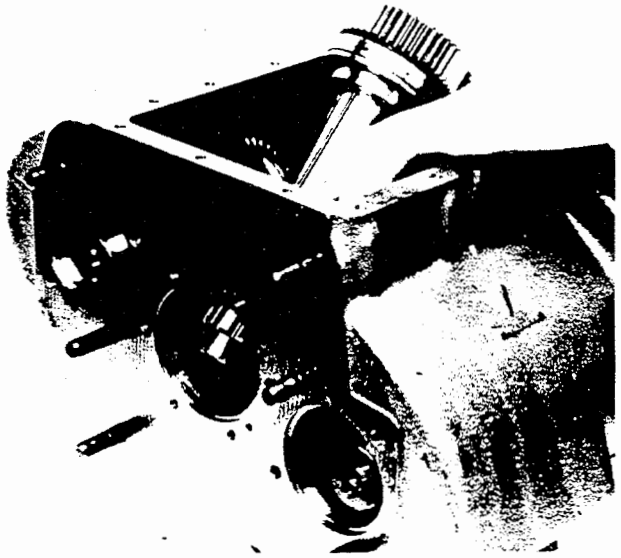


Figure 13-71. Removing Drive Gear Assembly.

6. Secure assembly in a vise, pilot end up, on drive gear O.D. The vise used should be equipped with either brass jaws or wood blocks to prevent damage to the teeth of drive gear (figure 13-72).

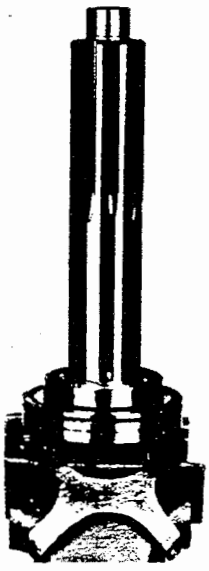


Figure 13-72. Securing Drive Gear Assembly In Vise.

. Use a punch and maul to relieve the bearing nut where peened into shaft (figure 13-73).

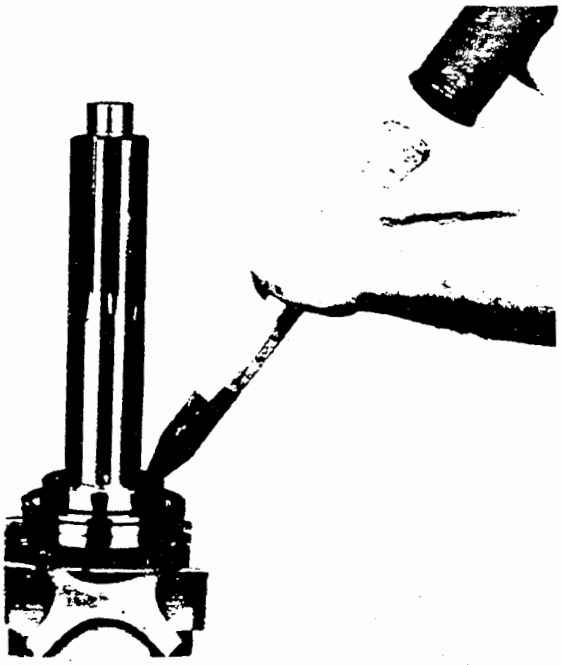


Figure 13-73. Flattening Bearing Nut Peen.

3. Turn the bearing nut from shaft, left hand thread (figure 13-74).

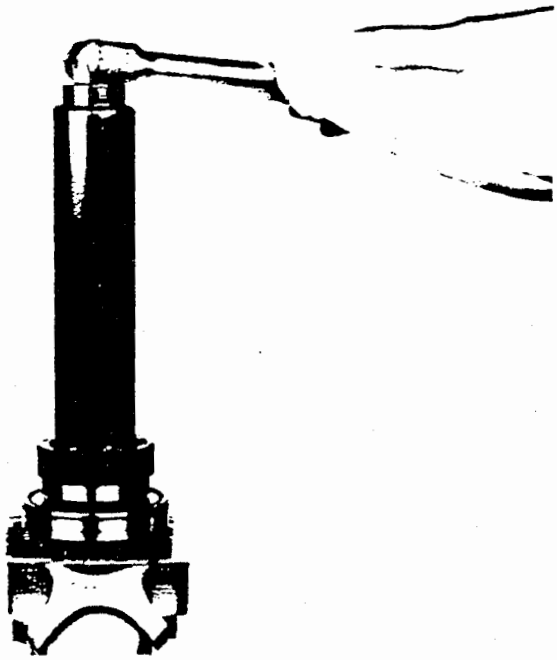
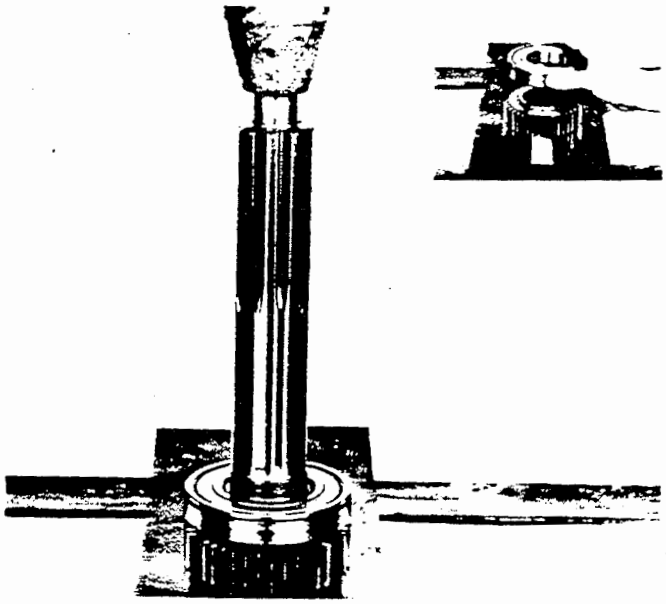


Figure 13-74. Bearing Nut Removal.

9. Using the rear face of the drive gear as a base, mount the assembly in a press, and press the shaft through the gear to unseat bearing from shaft. If necessary, remove snap ring from drive gear I.D. This will free the bearing, spacer and gear from shaft. Check the bushing in pocket of input shaft and replace if damaged or worn (figure 13-75). Disassembly of drive shaft is complete.



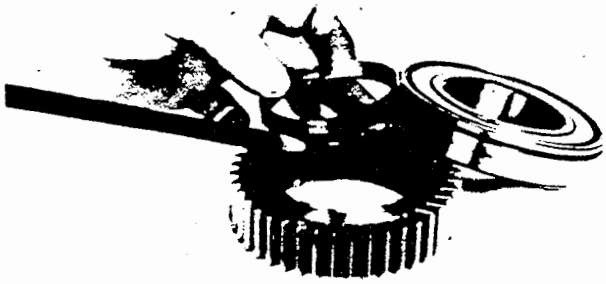


Figure 13-75. Separating Shaft and Gear Components.

MC-9 MAINTENANCE MANUAL

CHANGING INPUT SHAFT

In some cases, it may be necessary to replace only the input shaft due to clutch wear on the splines. In these instances, the input shaft can be removed without disassembling the transmission other than removing the shifting bar housing assembly. Removal of the clutch housing is optional. Following is this procedure:

REMOVAL

1. Remove remote control and shifter housing and shift bar housing assemblies from transmission.
2. Remove the front bearing cover.
3. Engage the mainshaft sliding clutches in two gears and remove the drive gear bearing nut.
4. Move the drive gear assembly as far forward as possible and remove the drive gear bearing.
5. Remove the spacer from input shaft.
6. From the front, remove the retaining ring from I.D. of drive gear.
7. Pull the input shaft forward and from splines of drive gear.

INSTALLATION

1. Install new input shaft into splines of drive gear just far enough to expose retaining ring groove in I.D. of drive gear.
2. Install retaining ring in I.D. of drive gear.
3. Install spacer on shaft against drive gear.
4. Install drive gear bearing on shaft and into case bore.
5. Install a new drive gear bearing nut, left-hand thread. Clean threads of nut and input shaft before applying Loctite sealant to threads of both parts. Use 250-300 ft. lbs. (339-407 Nm) torque to tighten nut.
6. Peen nut into milled slots of input shaft.
7. Reinstall front bearing cover, shift bar housing and remove control and shifter housing assemblies.

NOTE: The above instructions are for changing the input shaft only. To change the drive gear, removal of the mainshaft assembly and the countershaft bearings is necessary.

REMOVAL AND DISASSEMBLY OF COUNTERSHAFT ASSEMBLIES

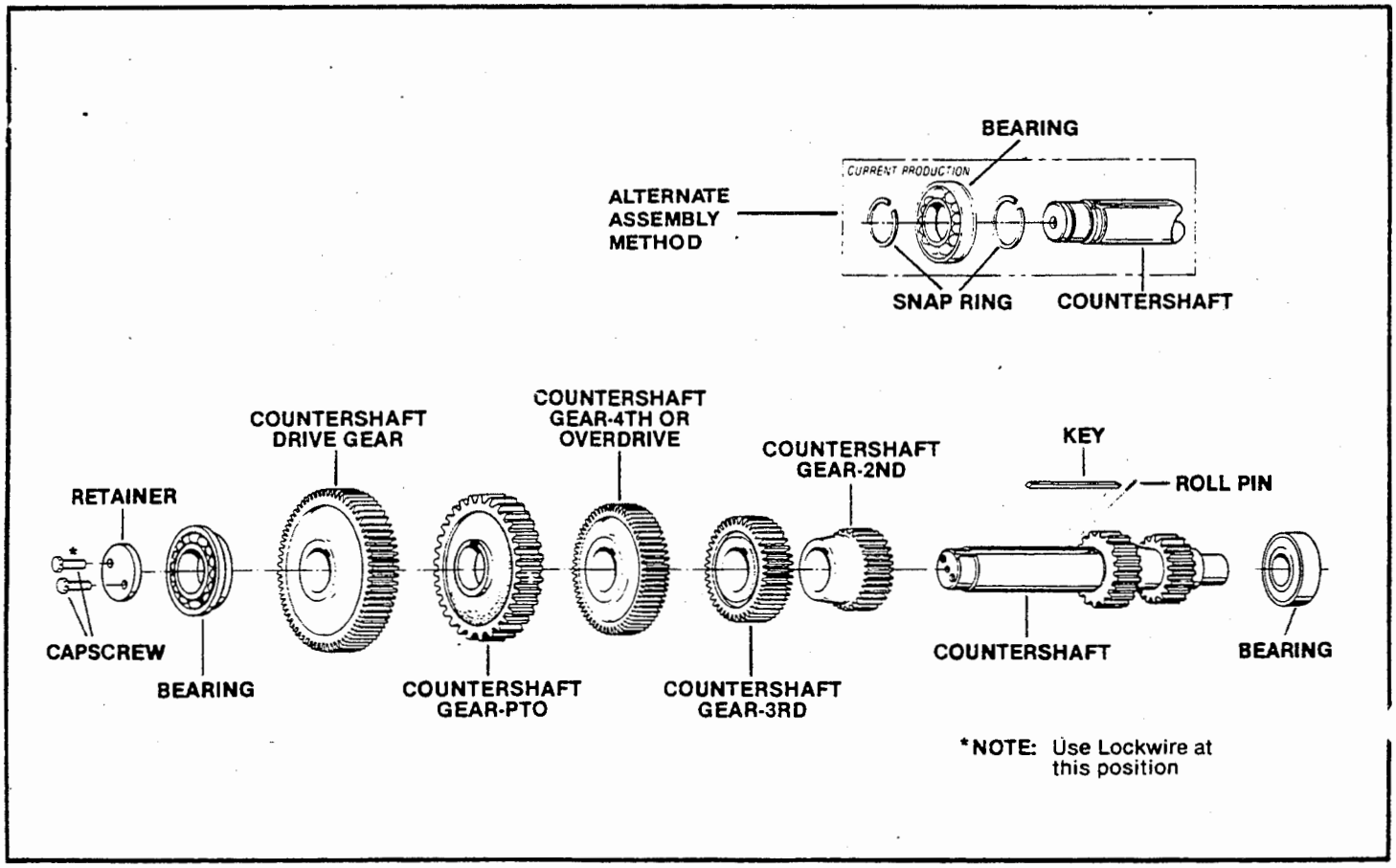


Figure 13-76. Countershaft and Related Gears.

1. If not already done, remove front and rear bearings of left countershaft as previously described.

2. Move either countershaft assembly to the rear, lift front of shaft to the center of case by the drive and PTO gears and remove through top of case. Repeat same process for other countershaft assembly (figure 13-77).

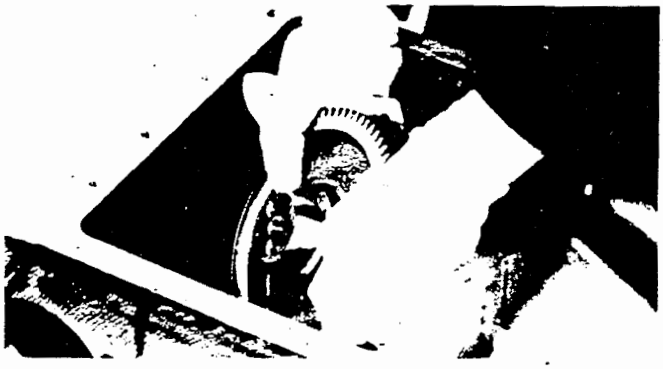


Figure 13-77. Removing Countershaft Assembly.

NOTE: Except for the PTO gears, the left and right countershaft assemblies are identical. Disassembly of each should be performed in the same manner.

3. For models equipped with a countershaft gear retaining snap ring in groove nearest to drive gear, remove snap ring from countershaft.

4. Press the drive gear, PTO gear, 4th speed gear, and 3rd speed gear from countershaft. Use caution when pressing gears as it is necessary to press these gears off in a cluster of four (figure 13-78).

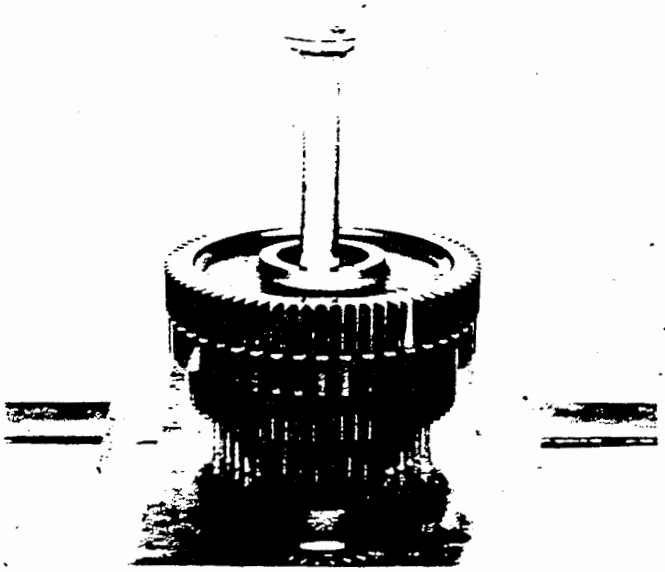


Figure 13-78. Pressing Gears Off Countershaft.

5. Press the 2nd speed gear from countershaft (figure 13-79).

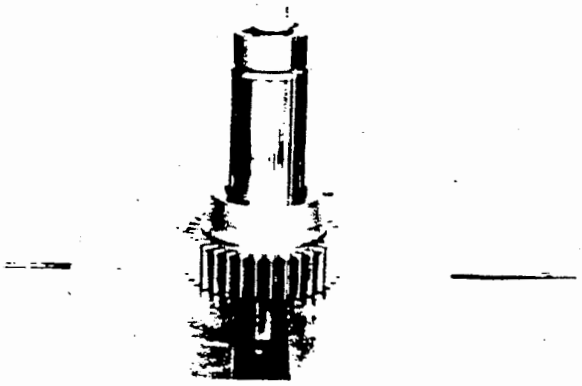


Figure 13-79. Pressing 2nd Speed Gear Off Countershaft.

6. If necessary, remove the key and roll pin from countershaft (figure 13-80).

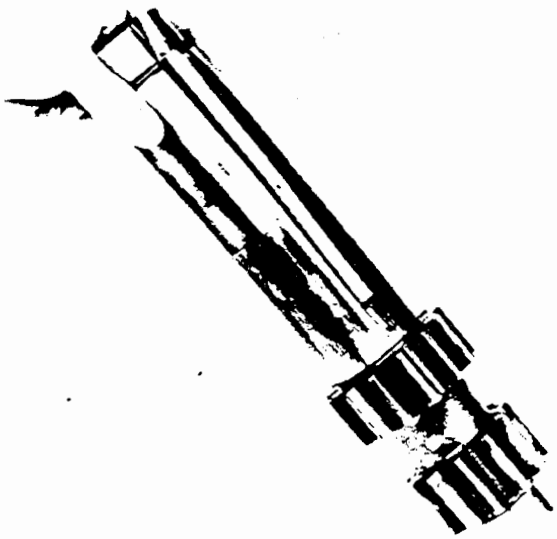


Figure 13-80. Removing Key and Roll Pin..

REMOVAL AND DISASSEMBLY OF RIGHT REVERSE IDLER GEAR ASSEMBLY

NOTE: Since the left and right reverse idler gear assemblies are identical, removal and disassembly of the Right Reverse Idler Gear Assembly should be performed in the same manner as previously described in this section.

TRANSMISSION PARTS INSPECTION

Before reassembling the transmission, the individual parts should be carefully checked. Replace those damaged from previous service. This inspection procedure should be carefully followed to ensure the maximum wear life from the rebuilt unit.

1. Wash all bearings in clean solvent. Check balls, rollers and races for pits and spalled areas. Replace bearings which are pitted or spalled.

2. Lubricate bearings which are not spalled or pitted and check for axial and radial clearances. Replace bearings with excessive clearances.

3. Check fits of bearings in case bores. If outer races turn freely in the bores, the case should be replaced.

4. Check operating gear teeth for pitting on the tooth faces. Gears with pitted teeth should be replaced.

5. Inspect all engaging gear teeth. Gears with teeth torn, tapered or reduced in length from clashing during shifting should be replaced.

6. Check axial clearances of gears. Where excessive clearance is found, check gear retaining ring, washer, spacer and gear hub excessive wear. Maintain .005" to .012" axial clearance on mainshaft forward speed gears, .005" minimum on reverse gear.

7. Check splines on all shafts for wear. If sliding clutch gears, companion flange or clutch hub have worn into the sides of the splines, the shafts in this condition should be replaced.

8. Check surfaces of all thrust washers. Washers scored or reduced in thickness should be replaced.

9. Check bearing sleeve for wear from action of roller bearings.

10. Inspect all gray iron parts for cracks and breaks. Replace or repair parts found to be damaged. Heavy castings may be welded or brazed providing the cracks do not extend into bearing bores or bolting surfaces.

11. Check clutch release parts. Replace yokes worn at cam surfaces and bearing carrier worn at contact pads.

12. Check pedal shafts. Replace those worn at bearing surfaces.

13. Check yokes and blocks for wear at pads and lever slot. Replace worn parts.

14. Check yokes for alignment. Straighten those which are sprung.

15. Check lockscrews in yokes and blocks. Tighten and rewire those found loose.

16. If housing has been dismantled, inspect neutral notches of shifting bars for wear from interlock balls. Bars indented at points adjacent to the neutral notch should be replaced.

17. Check pivot pin and corresponding slot in lever for wear. Replace both parts if worn.

18. Check covers for wear from thrust of adjacent bearing. Replace covers worn and grooved from thrust of bearing outer race.

19. Check bores of covers for wear. Replace those worn oversize.

20. Check oil return threads in front bearing cover. If sealing action of threads has been destroyed by contact with input shaft, replace the cover.

21. Check oil seal in rear bearing cover. If sealing action of lip has been destroyed, replace seal.

REASSEMBLY

CAUTION: Make sure that interiors of case and housings are clean. It is important that dirt be kept out of transmission during reassembly. Dirt is abrasive and can damage polished surfaces of bearings and washers.

Use new gaskets throughout the transmission as it is being rebuilt. Make sure all gaskets are installed, as omission of a gasket can result in oil leakage or misalignment of bearing covers.

To prevent oil leakage, use shellac on all capscrews.

Coat all thrust washers and splines of shafts with Lubriplate during installation to provide initial lubrication, preventing scoring and galling.

Use of flanged-end bearing drivers is recommended for the installation of bearings. These drivers apply equal force to both races of bearing, preventing damage to balls and races and maintaining correct bearing alignment with shaft and bore. If tubular or sleeve type driver is used, apply force only to inner race.

Pull the companion flange tightly into place with the output shaft nut, tightening to 400-450 ft. lbs. (542-610 Nm) torque. Be sure that the spacer has been installed on the yoke. Failure to pull the yoke or flange tightly into place will permit the shaft to move axially with resultant damage to rear bearing. Figure 13-59 shows the transmission parts in an exploded view.

TIMING

Timing is mentioned at various points in subsequent pages dealing with the transmission reassembly and installation. It is recommended that the procedures pertaining to timing, which are given below, be referred to whenever timing is involved.

It is essential that proper timing procedures are carried out during reassembly and installation. Proper timing assures that the countershaft gear teeth will come into contact with the mating mainshaft gear teeth at the same time, allowing the mainshaft gears to center on the mainshaft and split the load between the countershaft gear assemblies. If improperly timed, however, the mainshaft gears would climb out of equilibrium, resulting in unequal tooth contact between meshing gears that would lead to more serious damage occurring to the transmission later.

By design, the timing of only one set of gears is necessary — the drive gear set. It is a rather simple procedure, consisting of marking the proper teeth of the main and countershaft drive gears prior to installation of the complete assemblies in the case and meshing those marked gear teeth during assembly.

MC-9 MAINTENANCE MANUAL

ARKING COUNTERSHAFT DRIVE GEAR TEETH

1. Prior to placing each countershaft assembly into case, clearly mark on each drive gear the gear tooth which is directly over the keyway in gear (see figure 13-81). This tooth is stamped with an "O" to aid identification.

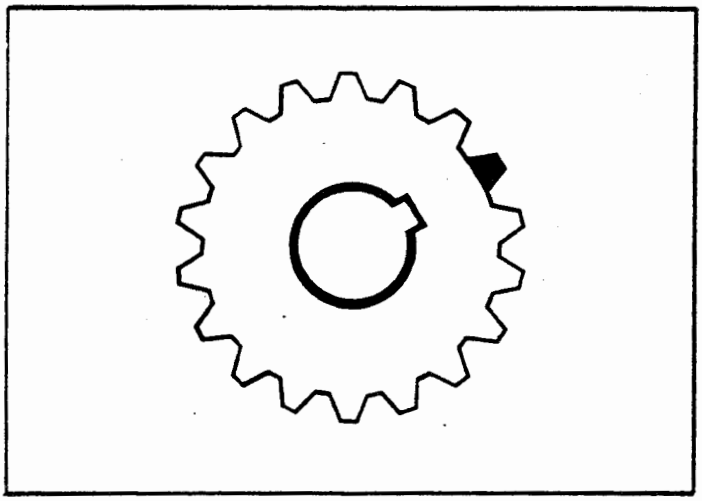


Figure 13-81. Tooth On Countershaft Drive Gear Directly Over Keyway Marked For Timing.

MARKING MAIN DRIVE GEAR TEETH

1. Mark *any* two adjacent teeth on the main drive gear.
2. Mark the two adjacent teeth on the main drive gear which are directly opposite the first set marked. There should be an equal number of teeth between the markings on each side of gear (see figure 13-82).

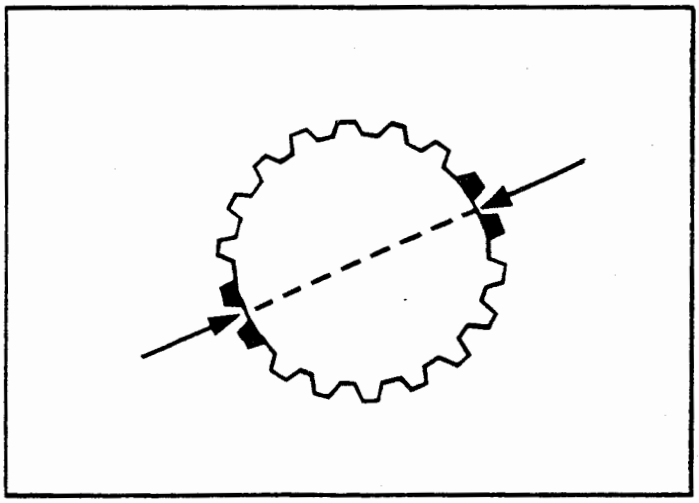


Figure 13-82. Main Drive Gear Teeth Correctly Marked For Timing.

MESHING MARKED COUNTERSHAFT DRIVE GEAR TEETH WITH MARKED MAIN DRIVE GEAR TEETH

After installing main drive gear and mainshaft assemblies, the countershaft bearings are installed to complete countershaft installation.

1. When installing bearings on the left countershaft, mesh the marked countershaft drive gear tooth between two marked teeth on the main drive gear. Repeat the procedure when installing the right countershaft bearings (see figure 13-83).

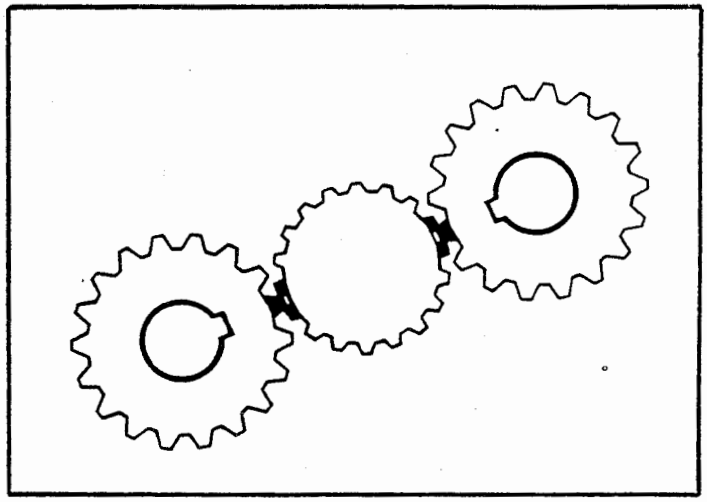


Figure 13-83. Countershaft Drive Gear Teeth Meshed With Main Drive Gear Teeth For Proper Timing.

REASSEMBLY AND INSTALLATION OF RIGHT REVERSE IDLER GEAR ASSEMBLY

1. Install plug in oil channel in idler shaft (figure 13-84).



Figure 13-84. Pipe Plug in Idler Shaft.

2. Press needle bearing into bore of reverse idler gear (figure 13-85).



Figure 13-85. Pressed-in Needle Bearing.

3. Place inner race of bearing in gear (figure 13-86).



Figure 13-86. Inserting Inner Race.

4. With the two thrust washers in position on each side of reverse idler gear, slide the idler shaft through bore in rear of case, gear, washers and bore of idler shaft support boss inside case. To make certain the slot in rear of idler shaft is properly located to secure lock plate with capscrew in case, align oil channel hole of idler shaft with that in top of idler shaft support boss (figure 13-87).

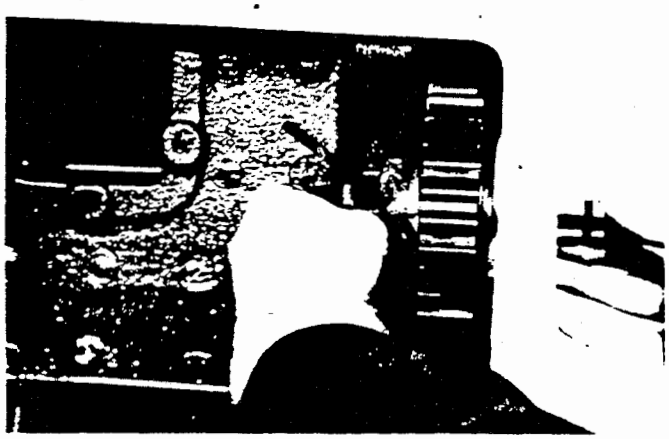


Figure 13-87. Installing Reverse Idler Gear and Shaft.

5. Install the lockplate in slot of idler shaft. Tighten capscrew securely (figure 13-88).



Figure 13-88. Installing Lockplate Capscrew.

Reassembly and installation of right reverse idler gear is now complete.

REASSEMBLY OF COUNTERSHAFTS

NOTE: Except for the power take-off gears, the countershafts are identical; reassembly is the same for each.

1. Install roll pin in bore located in keyway of countershaft.

2. Install the short key in countershaft, tapered end against roll pin.

3. Install the long key in keyway in countershaft (figure 13-89).

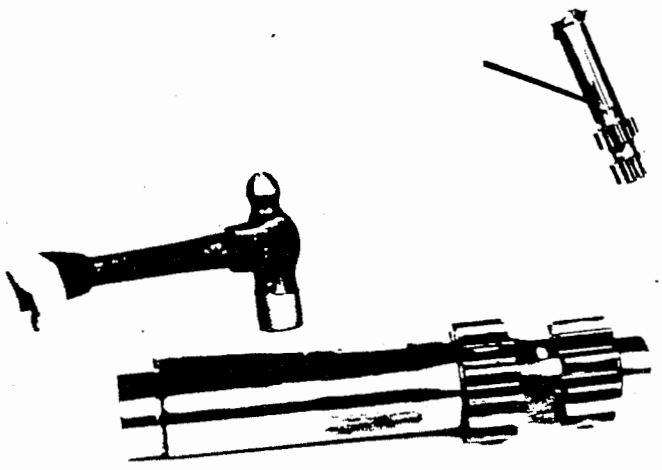


Figure 13-89. Installing Long Key.

4. Align keyway in gear with keys in shaft and press the 2nd speed gear on shaft, long hub toward front of shaft (figure 13-90).

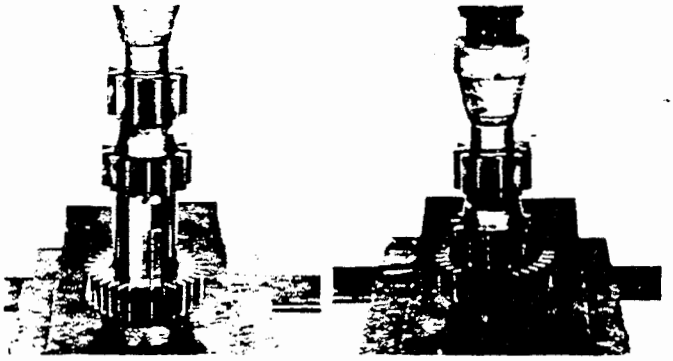


Figure 13-90. 2nd Speed Gear Installation.

5. Press the 3rd speed gear on countershaft, long hub toward 2nd speed gear (figure 13-91).

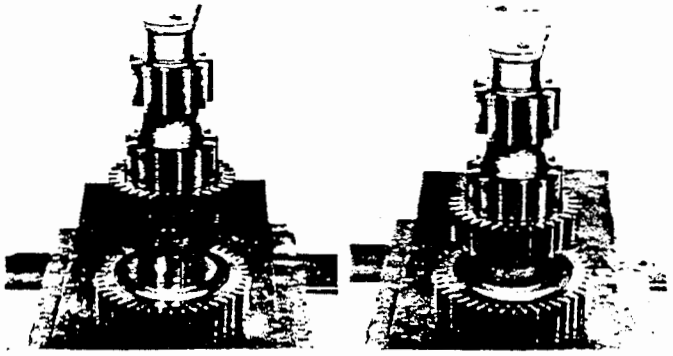


Figure 13-91. 3rd Speed Gear Installation.

6. Press the 4th speed gear on countershaft.

7. Press the power take-off gear on countershaft, bullet nose teeth toward rear of shaft (figure 13-92).

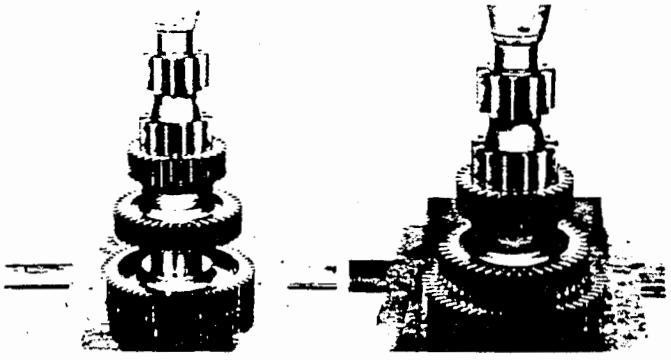


Figure 13-92. 4th Speed and PTO Gear Installation.

NOTE: The left countershaft assembly has a 47-tooth PTO gear; the right assembly has a 45-tooth gear. Mark each assembly as "right" or "left."

8. Press the drive gear on countershaft (figure 13-93).

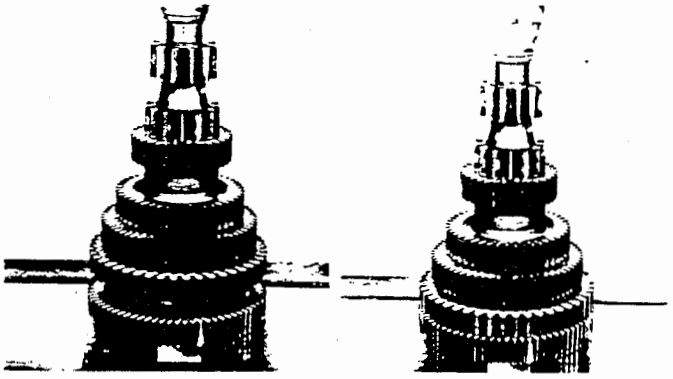


Figure 13-93. Drive Gear Installation.

9. Install countershaft gear snap ring in groove nearest to drive gear.

NOTE: Mark countershaft drive gears for timing. On the drive gear of each countershaft, mark tooth that is aligned with keyway in gear; this tooth will be stamped with an "O" (figure 13-94).

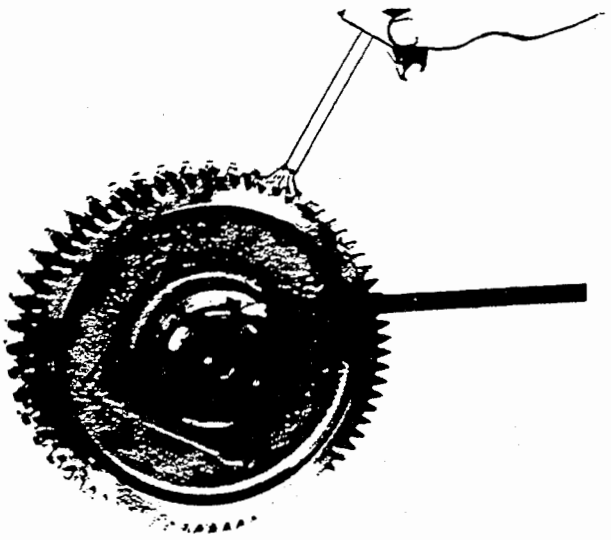


Figure 13-94. Alignment Mark.

PARTIAL INSTALLATION OF COUNTERSHAFT ASSEMBLIES

1. Place the left countershaft assembly with the 47-tooth PTO gear into position in case, small end through the left rear countershaft bore. Do not install bearings at this time (figure 13-95).

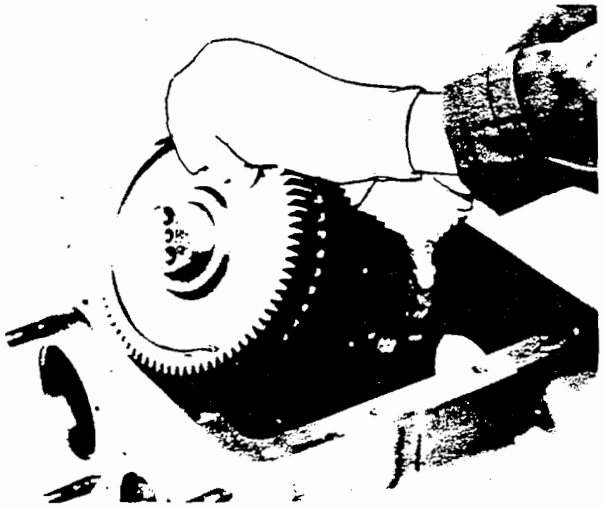


Figure 13-95. Positioning Left Countershaft.

2. Place the right countershaft assembly with the 45-tooth PTO gear into position in case, small end through right rear countershaft bore. Do not install bearings at this time (figure 13-96).

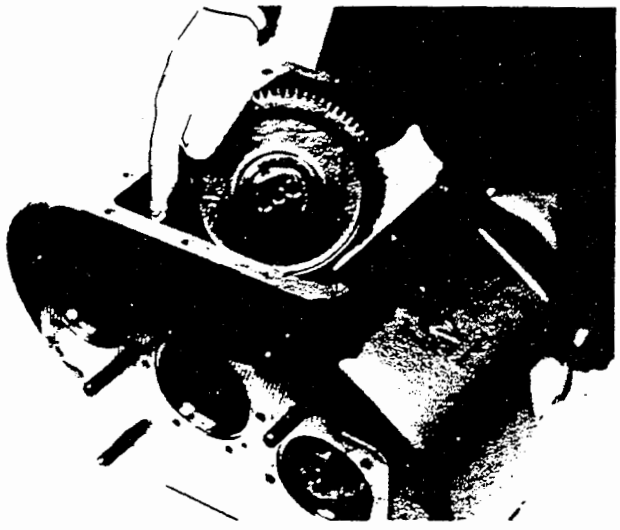


Figure 13-96. Positioning Right Countershaft.

REASSEMBLY AND INSTALLATION OF MAIN DRIVE GEAR ASSEMBLY

1. Install retaining ring in I.D. of drive gear (figure 13-97).

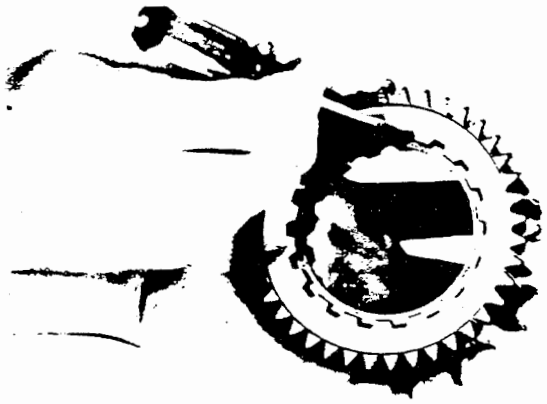


Figure 13-97. Installing Retaining Ring.

2. Install the drive gear on shaft, engaging internal splines of gear with teeth on shaft, retaining ring of gear toward the front (figure 13-98).

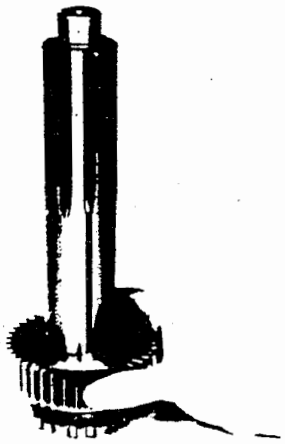


Figure 13-98. Drive Gear on Shaft.

3. Install the drive gear spacer on shaft and against gear (figure 13-99).



Figure 13-99. Installing Spacer.

MC-9 MAINTENANCE MANUAL

4. Press the drive gear bearing on shaft, shield to the front (figure 13-100).

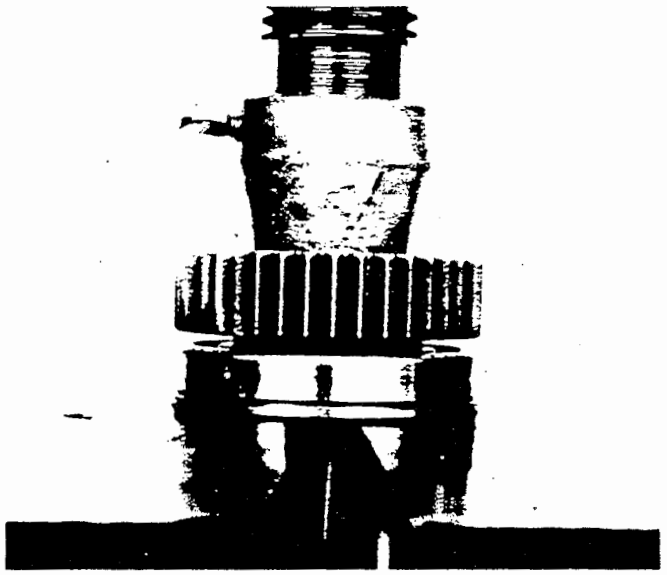


Figure 13-100. Drive Gear Bearing Installation.

5. Clean threads of input shaft and apply Loctite Threadker 277 to threads of new drive gear bearing nut. Do not reuse old nut.

6. Install the bearing nut on shaft, left hand threaded, tightened to 250-300 ft. lbs. (339-407 Nm) torque (figure 13-101).

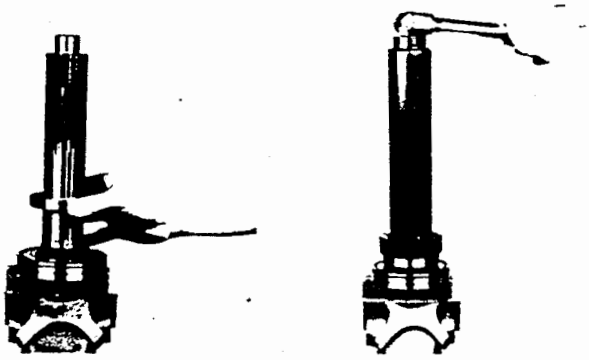


Figure 13-101. Bearing Nut Installation.

7. Peen the nut into the two milled slots (figure 13-102).



Figure 13-102. Peening Bearing Nut.

8. Match-mark the drive gear for timing. Mark any two adjacent teeth on the drive gear, then mark two adjacent teeth which are directly opposite the first set marked (figure 13-103).

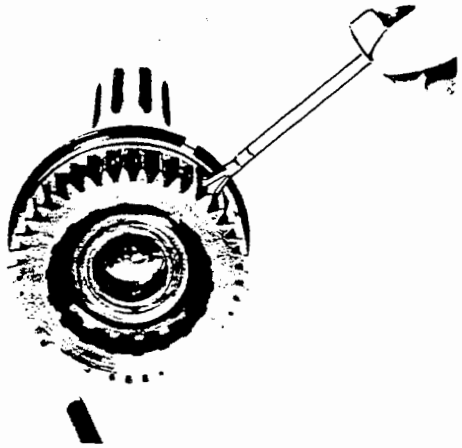


Figure 13-103. Drive Gear Timing Marks.

9. Remove the retaining ring from drive gear bearing (figure 13-104).

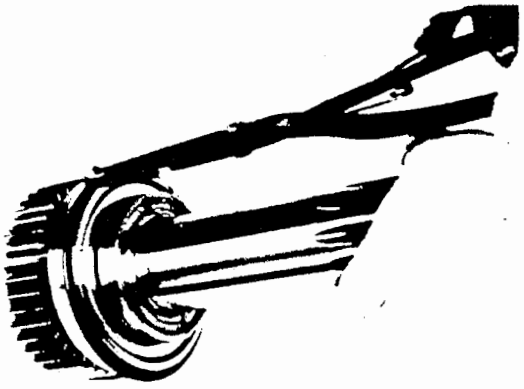


Figure 13-104. Removing Retaining Ring.

10. Insert the drive shaft from inside case through front bore. Seat the drive gear bearing in case bore and move assembly forward until retaining ring groove in bearing is exposed (figure 13-105).

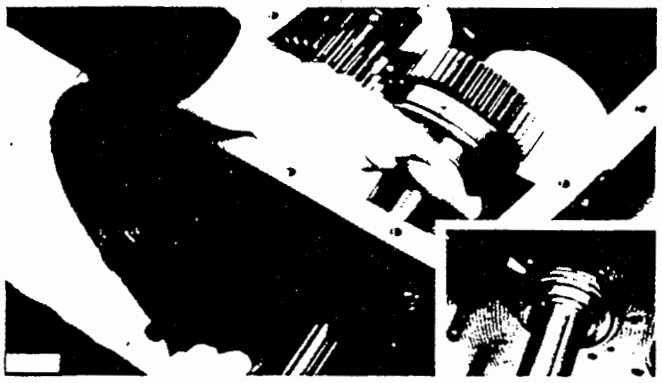


Figure 13-105. Installing Drive Gear Assembly.

11. Install retaining ring (figure 13-106).



Figure 13-106. Installing Retaining Ring.

12. Seat bearing in case bore and install the drive gear bearing cover with new gasket, aligning oil return slot in cover with oil return bore in case. Tighten capscrews securely (figure 13-107).



Figure 13-107. Installing Drive Gear Bearing Cover.

COMPLETED INSTALLATION OF LEFT COUNTERSHAFT ASSEMBLY

1. Insert countershaft support tool in rear bearing bore (figure 13-108).



Figure 13-108. Supporting Countershaft.

2. Mesh the marked tooth of left countershaft drive gear with ıer set of two marked timing teeth of main drive gear (figure 13-109).

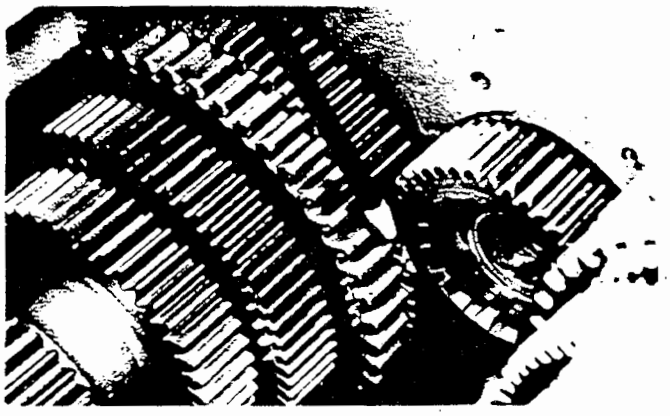


Figure 13-109. Meshing Marked Teeth.

3. With timing teeth still in mesh, install countershaft front bearing. Center countershaft in case bore using a small screwdriver inserted through bearing I.D. and in bell center or either threaded hole in end of shaft (figure 13-110).

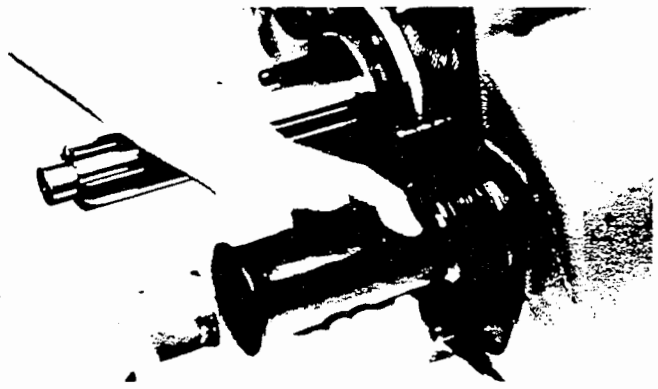


Figure 13-110. Installing Countershaft.

4. Install retainer plate, secure with capscrews, and lockwire. For models equipped with groove in countershaft for front bearing retaining snap ring, install snap ring in groove (figure 13-111).

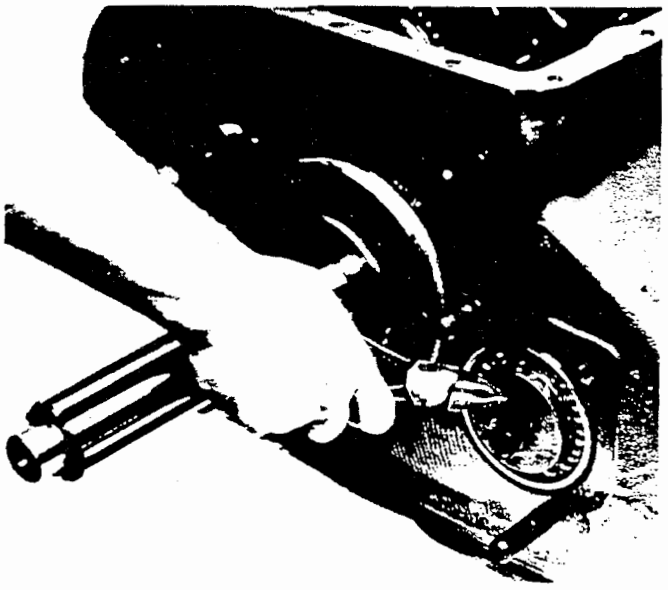


Figure 13-111. Installing Lockplate and Snapring.

5. Remove countershaft support tool from rear case bore and install countershaft rear bearing with the larger I.D. lead chamfer toward front of transmission (figure 13-112).

NOTE: If damage to original bearing resulted from punch and maul removal, replace with new rear bearing.

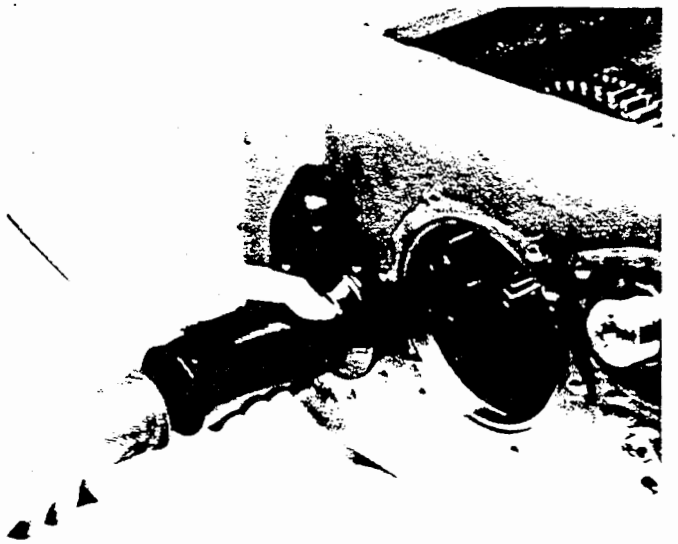


Figure 13-112. Installing Rear Bearing.

MC-9 MAINTENANCE MANUAL

PARTIAL REASSEMBLY OF OUTPUT SHAFT ASSEMBLY

1. Press the front bearing on output shaft, snap ring to the rear (figure 13-113).

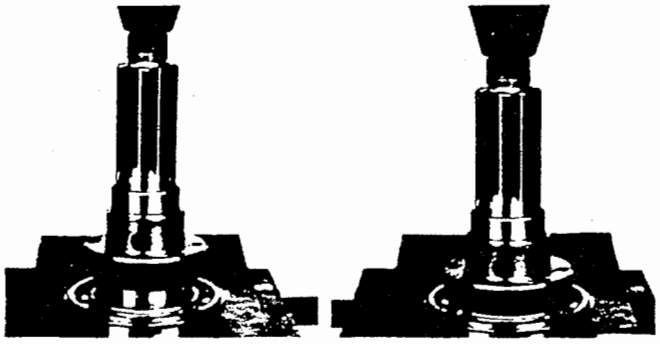


Figure 13-113. Pressing on Front Bearing.

2. Clean threads of output shaft and bearing nut. Apply loctite grade 277 sealant to threads of nut.

3. Install the bearing nut on threads of output shaft and torque to 250-300 ft. lbs. (figure 13-114).

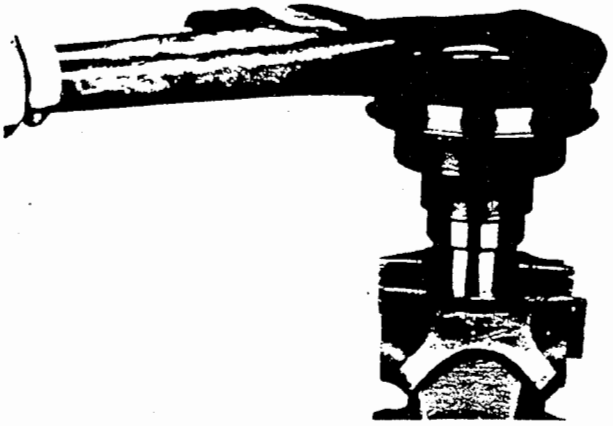


Figure 13-114. Installing Bearing Nut.

4. Position the key spacer ring on output shaft using the two 5/16-24 x 5/8" capscrews, but do not tighten (figure 13-115).

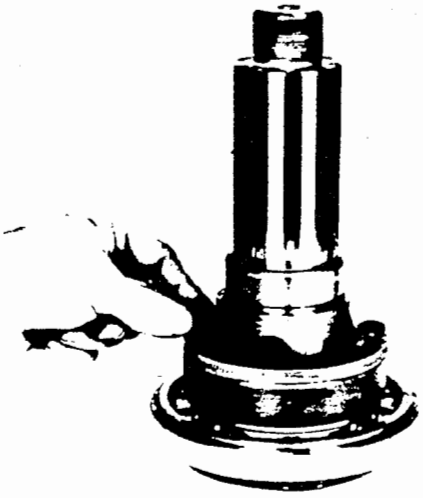


Figure 13-115. Attaching Key Spacer Ring.

REASSEMBLY OF MAINSHAFT

1. Place mainshaft in vise equipped with brass jaws or wood blocks, pilot end down.

NOTE: If previously removed, install all corresponding retaining rings in mainshaft gears with the exception of reverse gear.

2. Install 3rd speed washer with flat side down in the 4th groove of mainshaft. Rotate washer to align splines of washer with those of the mainshaft and install the long key in mainshaft keyway (figure 13-116).

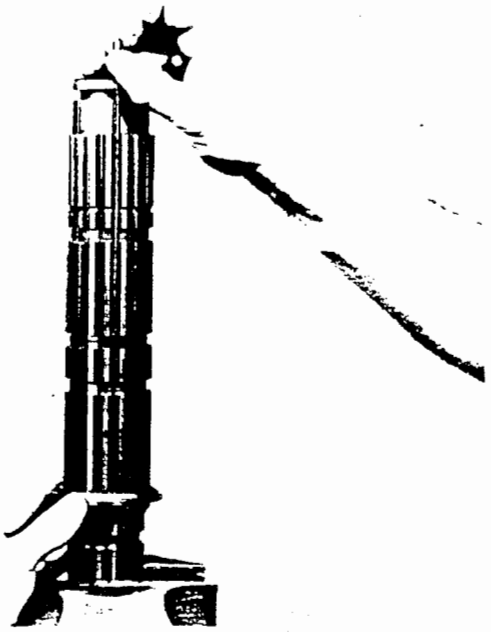


Figure 13-116. 3rd Speed Washer Installation.

3. Install 2nd-3rd speed sliding clutch, aligning missing internal spline of sliding clutch with key (figure 13-117).

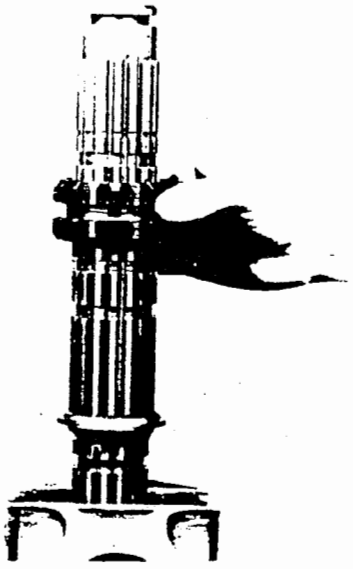


Figure 13-117. Installing 2nd/3rd Sliding Clutch.

MC-9 MAINTENANCE MANUAL

4. Remove key and install 2nd speed gear washer, flat side up, next groove of mainshaft. Rotate washer to align splines of washer with those of mainshaft and reinsert key (figure 13-118).

NOTE: The long key is moved downward to engage washers as they are positioned on mainshaft.

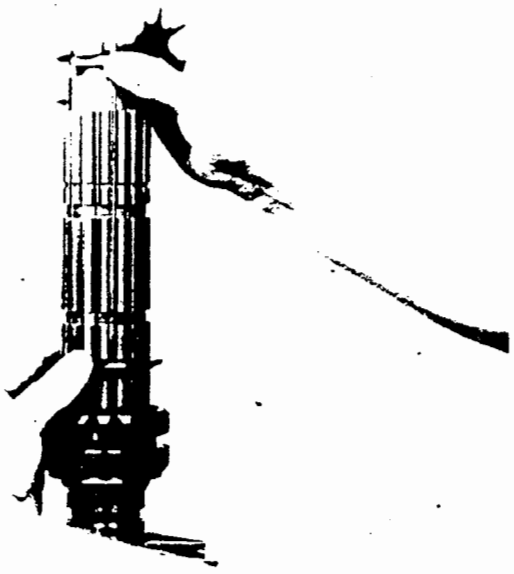


Figure 13-118. 2nd Speed Washer Installation.

5. Install spacer against 2nd speed washer (figure 13-119).

NOTE: Gear washers are internally splined and locked to mainshaft by key. Gear spacers are externally splined to engage with splines in gear hubs. There is one washer and one spacer for each gear in mainshaft assembly.

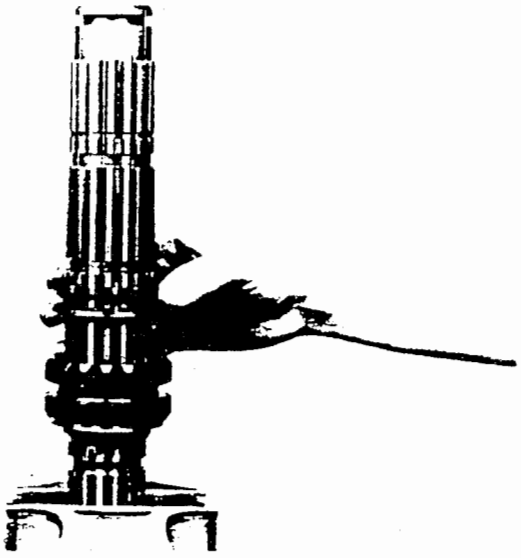


Figure 13-119. Spacer Against 2nd Speed Washer.

6. Install 2nd speed gear, clutching teeth down. Engage clutching teeth of gear with external splines of spacer (figure 13-120).

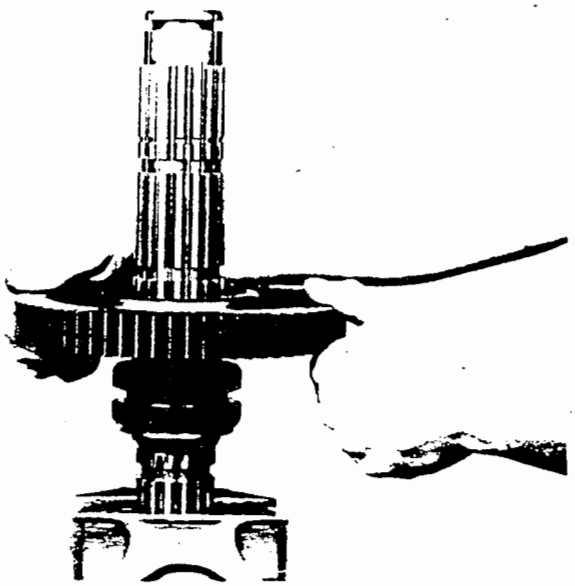


Figure 13-120. 2nd Speed Gear Installation.

7. Install 1st speed gear, clutching teeth up (figure 13-121).

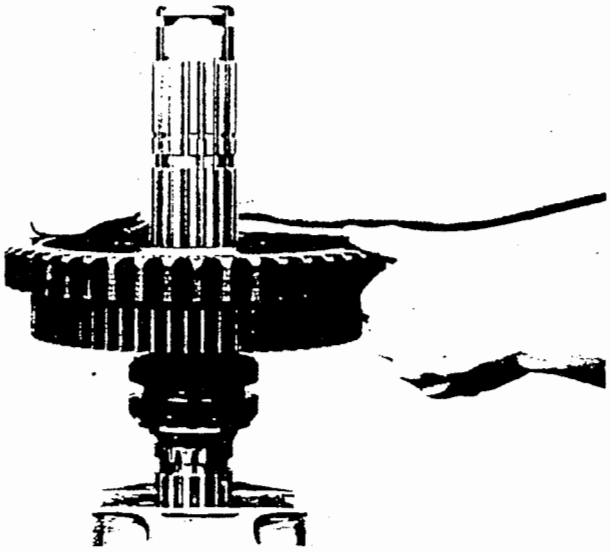


Figure 13-121. 1st Speed Gear Installation.

8. Install spacer in 1st speed gear, engaging external splines of spacer with clutching teeth of gear (figure 13-122).

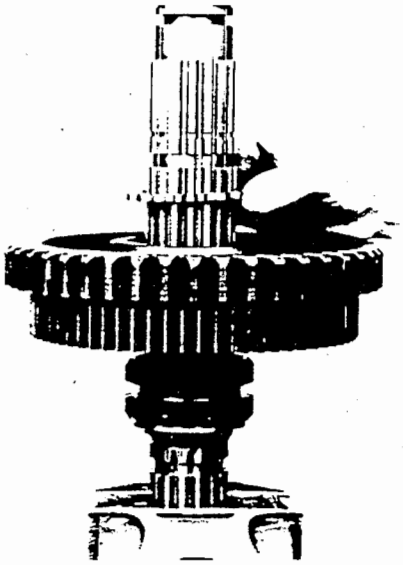


Figure 13-122. Installing Spacer.

9. Remove key and install 1st speed washer, flat side against spacer (figure 13-123).



Figure 13-123. Installing Washer.

10. Rotate washer to align splines of washer with those of mainshaft and reinsert key (figure 13-124).

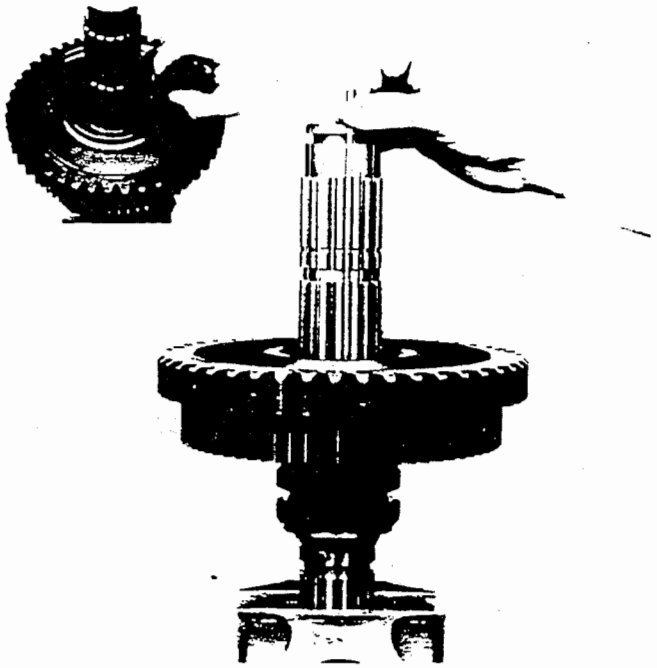


Figure 13-124. Key Re-insertion.

11. Insert two large screwdrivers between 1st and 2nd speed gears. Apply slight downward pressure on screwdriver handles to spread gears evenly. Making certain gear hubs are parallel, insert feeler gauge between hubs (figure 13-125). Correct axial clearance; should be from .005" to .012" (.127-.305 mm). If the clearance is less than the minimum .005" (9.127 mm) tolerance, the washer in the 1st speed gear should be replaced by a lower limit washer. This will increase the axial clearance between the gears. If the clearance checked is greater than the maximum .012" (.305 mm) tolerance, a higher limit washer should be installed in the 1st speed gear. This would decrease the axial clearance between the gears.

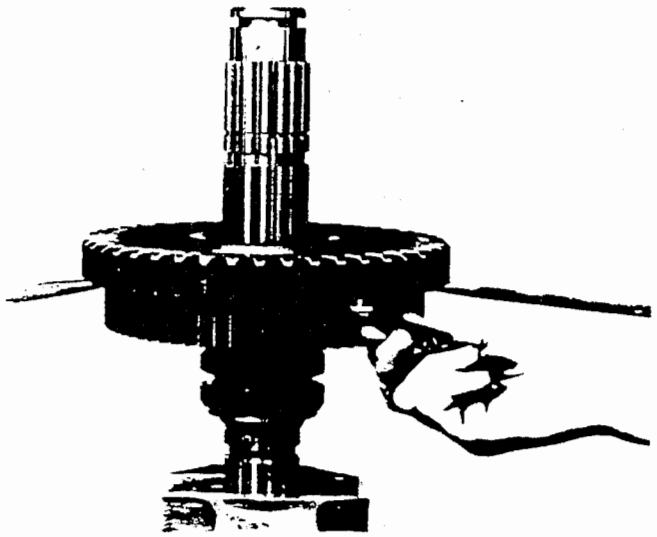


Figure 13-125. Checking Clearance Between Gears.

NOTE: For information on axial clearance (end play) on mainshaft gears, refer to Specifications at the end of this section.

12. Install 1st-reverse speed sliding clutch, aligning missing internal spline of sliding clutch with key in mainshaft (figure 13-126).

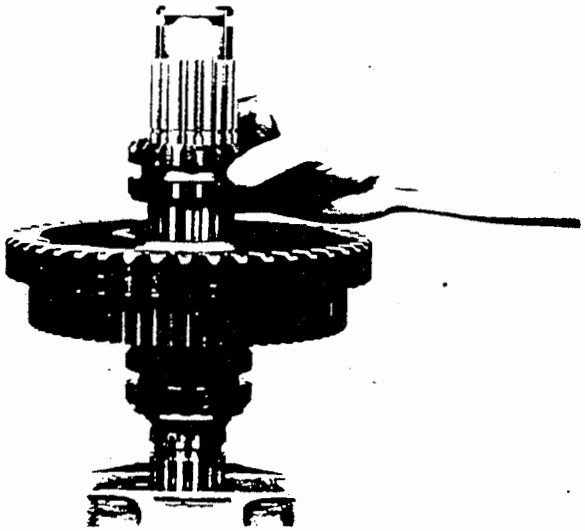


Figure 13-126. 1st-Reverse Sliding Clutch Installation.

13. Remove key and install reverse gear washer, flat side up, in last groove of mainshaft. Rotate washer to align splines of washer with those of mainshaft and reinsert key (figure 13-127).

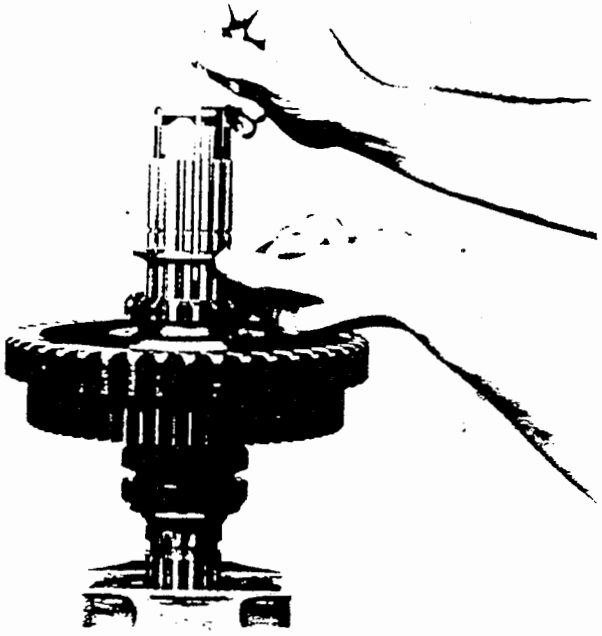


Figure 13-127. Reverse Gear Washer Installation.

14. Install spacer against reverse gear washer (figure 13-128).

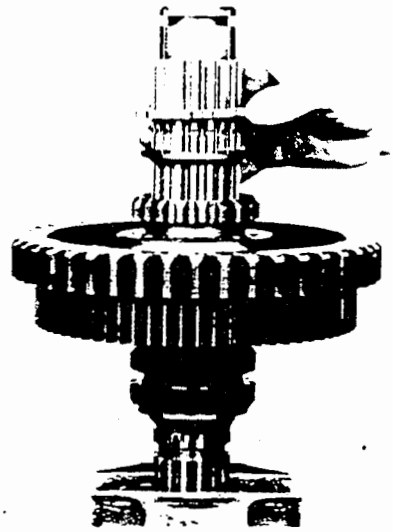


Figure 13-128. Spacer Installation.

15. Install retaining ring in groove at rear of mainshaft (figure 13-129).

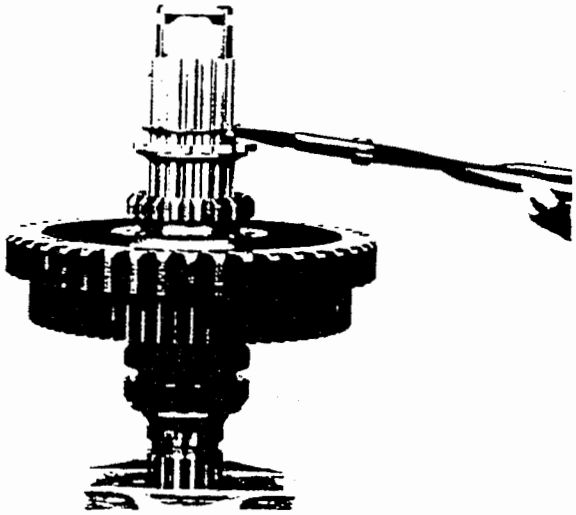


Figure 13-129. Retaining Ring Installation.

16. Reposition mainshaft assembly in vise, pilot end up (figure 13-130).

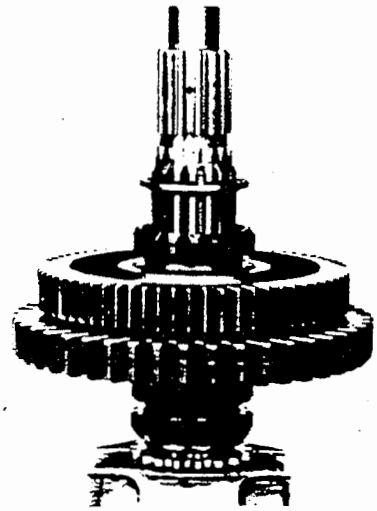


Figure 13-130. Mainshaft Repositioned in Vise.

17. Install spacer against flat side of 3rd speed gear washer (figure 13-131).

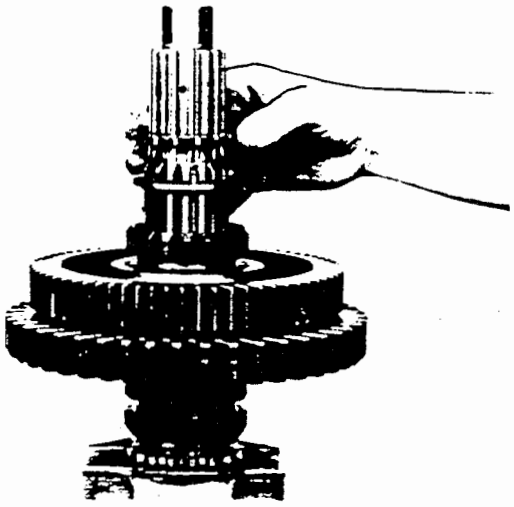


Figure 13-131. Installing Spacer.

18. Install 3rd speed gear, clutching teeth down. Engage clutching teeth of gear with external splines of spacer (figure 13-132).

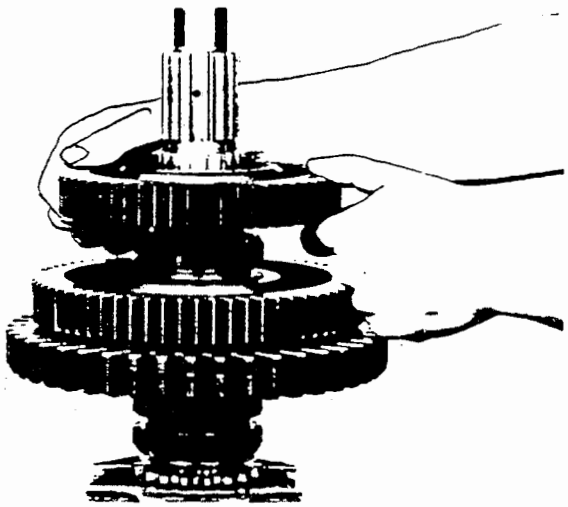


Figure 13-132. Installing 3rd Speed Gear.

19. Install 4th speed gear, clutching teeth up, against 3rd speed gear (figure 13-133).

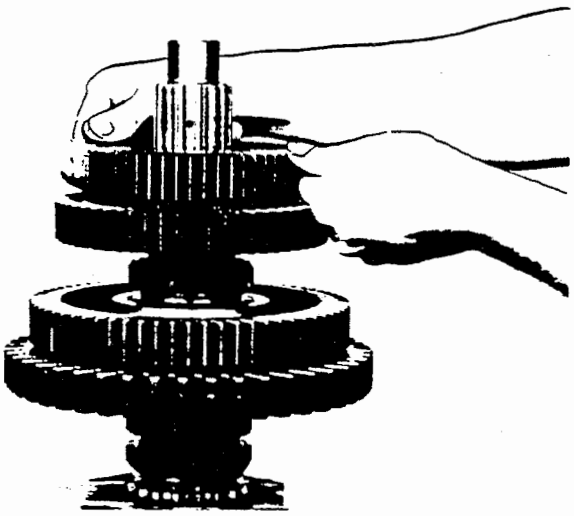


Figure 13-133. Installing 4th Speed Gear.

20. Install spacer in 4th speed gear engaging external splines of spacer with clutching teeth of gear (figure 13-134).

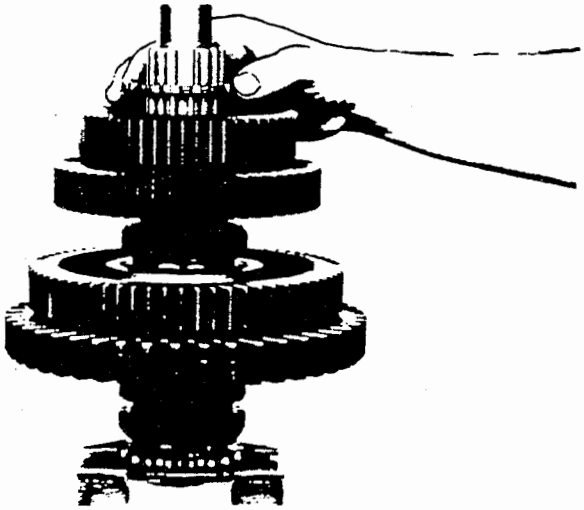


Figure 13-134. Installing Spacer in 4th Speed Gear.

21. Install 4th speed gear washer, flat side against spacer, in 4th speed gear. Rotate washer to align splines of washer with those of mainshaft and install short key in mainshaft keyway (figure 13-135).

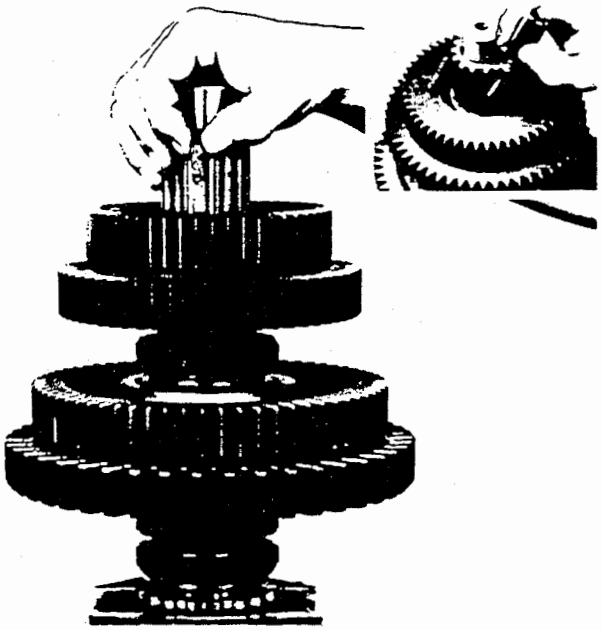


Figure 13-135. Short Key Installation.

22. Check axial clearances and make adjustments, if necessary, between the 3rd and 4th speed gears in the same manner as performed between the 1st and 2nd speed gears (figure 13-136).

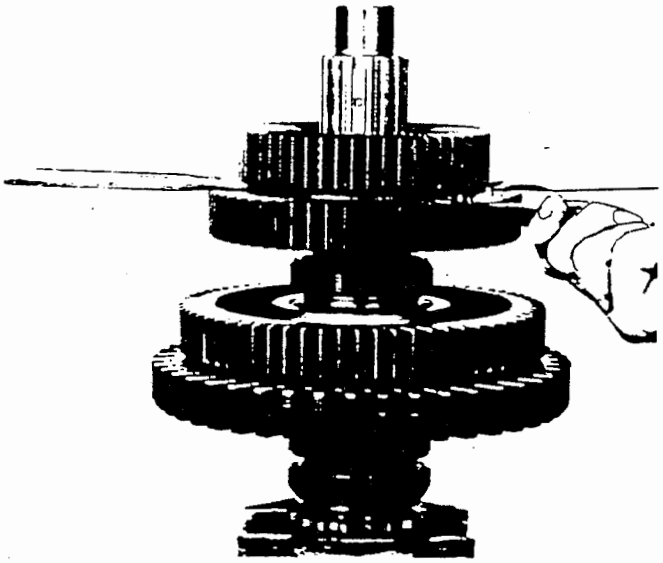


Figure 13-136. Checking Clearance.

23. Install 4th-5th speed sliding clutch, aligning missing internal spline of sliding clutch with key in mainshaft (figure 13-137).

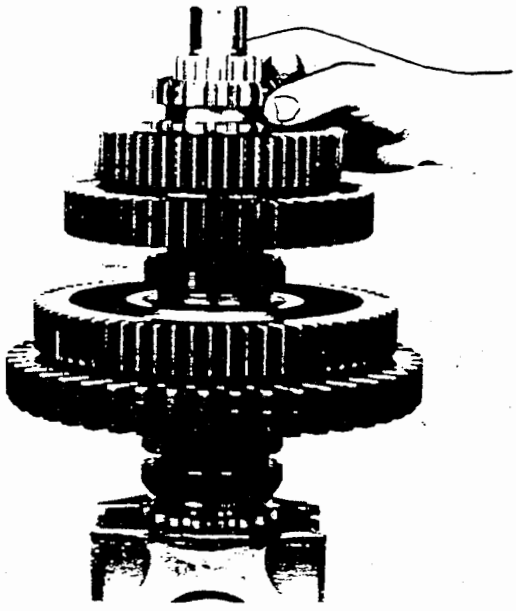


Figure 13-137. Installing 4/5th Speed Sliding Clutch.

24. Remove mainshaft assembly from vise. Install reverse gear on mainshaft over retaining ring in rear, clutching teeth toward front, and move it against 1st speed gear, engaging clutching teeth of gear with external splines of spacer (figure 13-138).

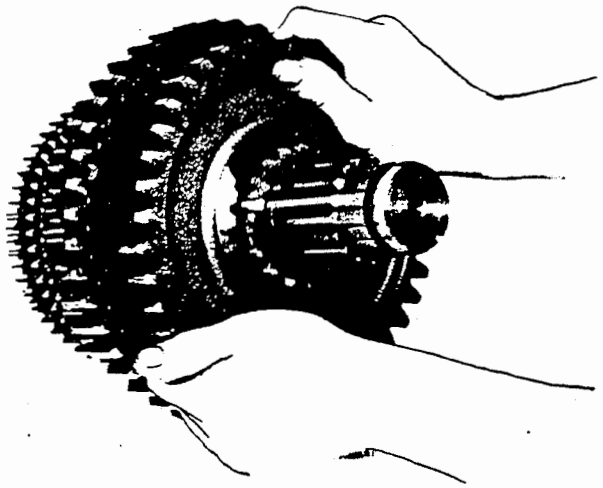


Figure 13-138. Installing 1st Speed Gear.

PARTIAL INSTALLATION OF MAINSHAFT ASSEMBLY

1. Move the right countershaft assembly as far as possible toward case wall (figure 13-139).

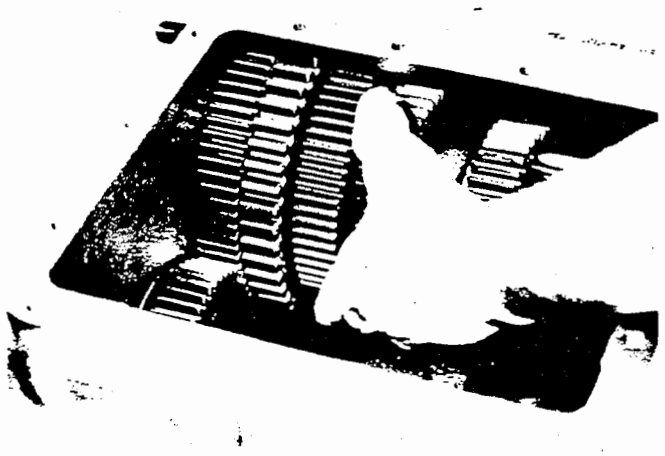


Figure 13-139. Positioning Countershaft Assembly.

2. With the reverse gear as far forward as possible, install the mainshaft into position in case, meshing corresponding gears on left countershaft with those on mainshaft (figure 13-140).

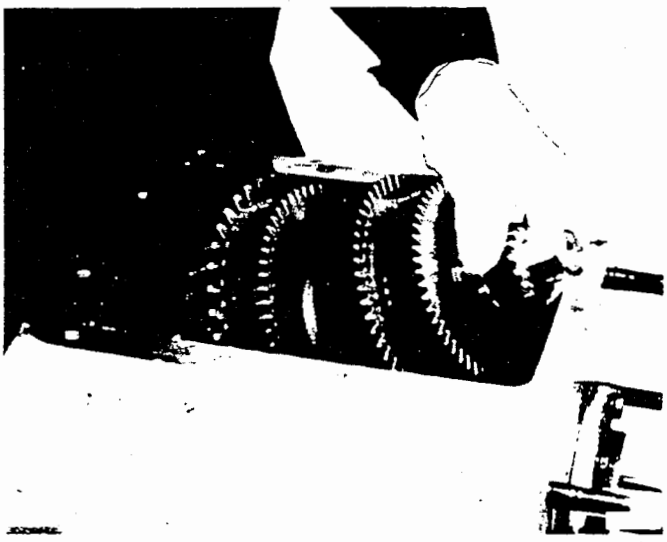


Figure 13-140. Mainshaft Assembly Installation.

3. Temporarily install the coupling gear, counterbore toward front of transmission, and partially reassembled output shaft assembly, engaging splines of output shaft with those of coupling gear, to center the rear of mainshaft assembly (figure 13-141).

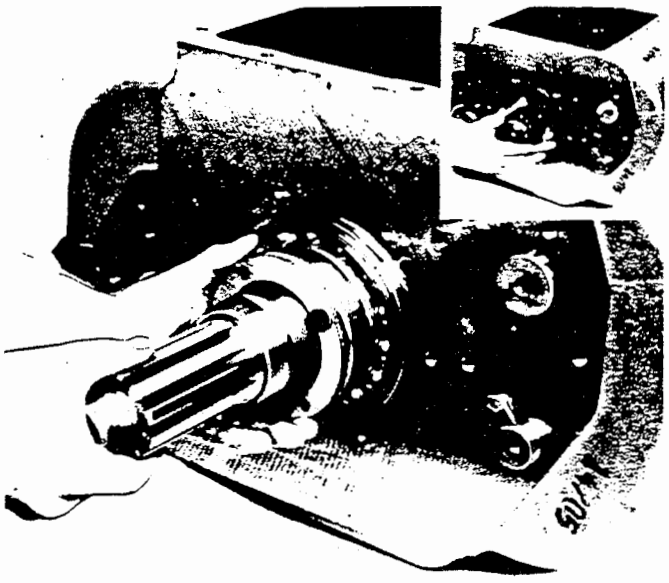


Figure 13-141. Centering Mainshaft Assembly.

MPLETION OF RIGHT
UNTERSHAFT INSTALLATION

NOTE: Left countershaft assembly must remain in time with main drive gear when timing right countershaft assembly.

1. With the right countershaft parallel with mainshaft, mesh the marked tooth of right countershaft drive gear with the remaining two marked timing teeth of main drive gear (figure 13-142).

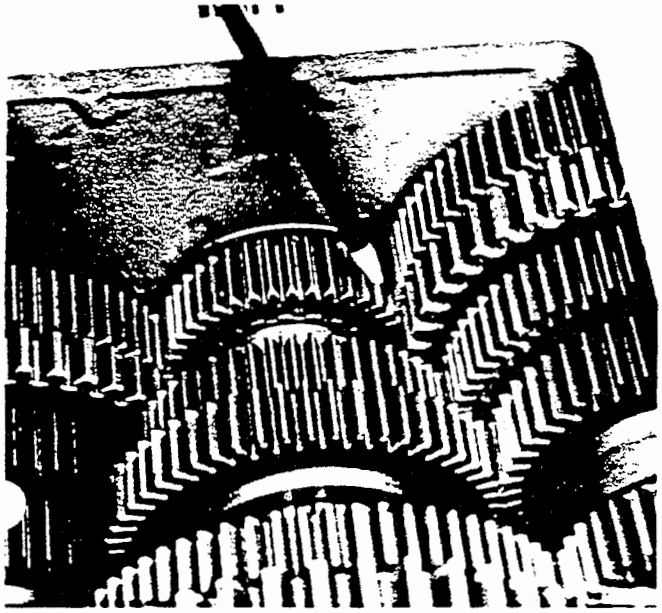


Figure 13-142. Engaging Timing Teeth.

2. Insert countershaft support tool in rear bearing bore (figure 13-143).

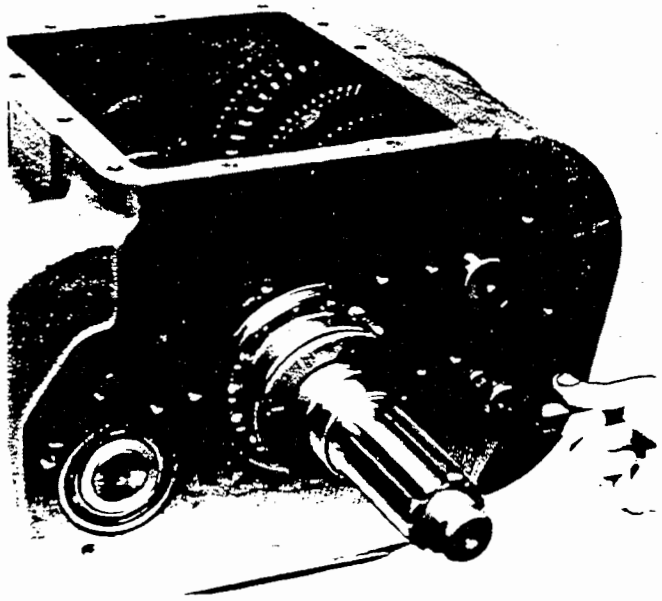


Figure 13-143. Placing Support Tool in Rear Bearing Bore.

3. With timing teeth still in mesh, install countershaft front bearing. Center countershaft in case bore using a small screwdriver inserted through bearing I.D. and in bell center or either threaded hole in end of shaft (figure 13-144).

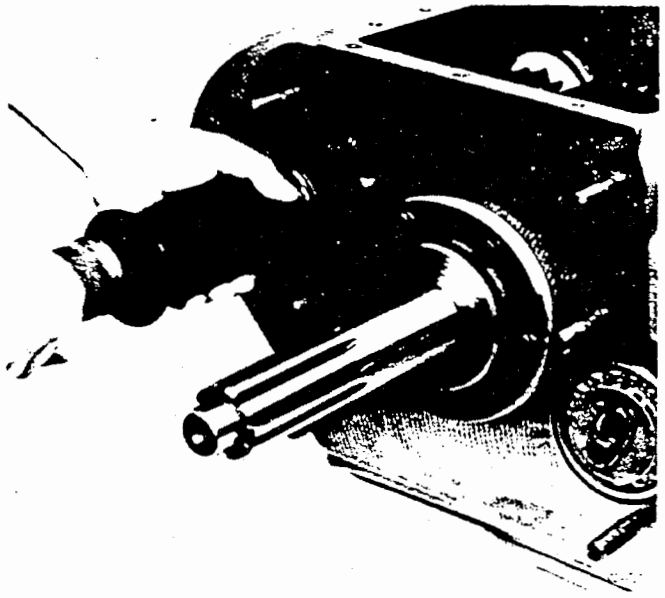


Figure 13-144. Front Bearing Installation.

4. Install retainer plate, secure with capscrews, and lockwire. For models otherwise equipped with front bearing retaining snap ring in groove of countershaft, install snap ring (figure 13-145).

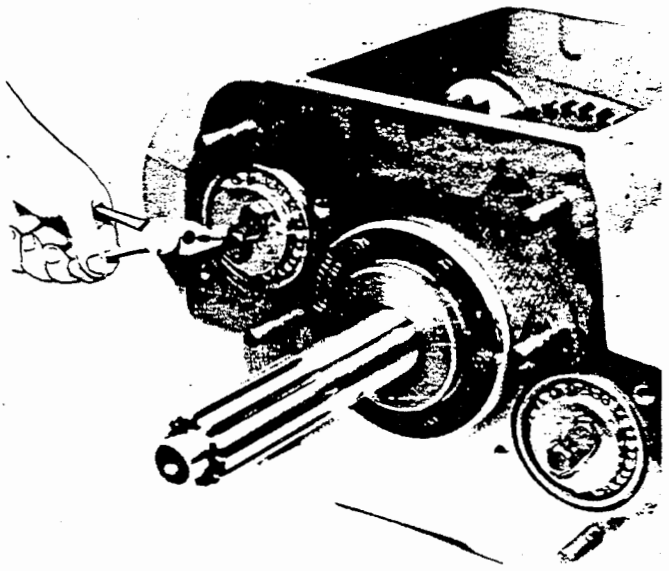


Figure 13-145. Installing Lockwires.

5. Remove countershaft support tool from rear case bore and install countershaft rear bearing with the larger I.D. lead chamfer toward front of transmission (figure 13-146).

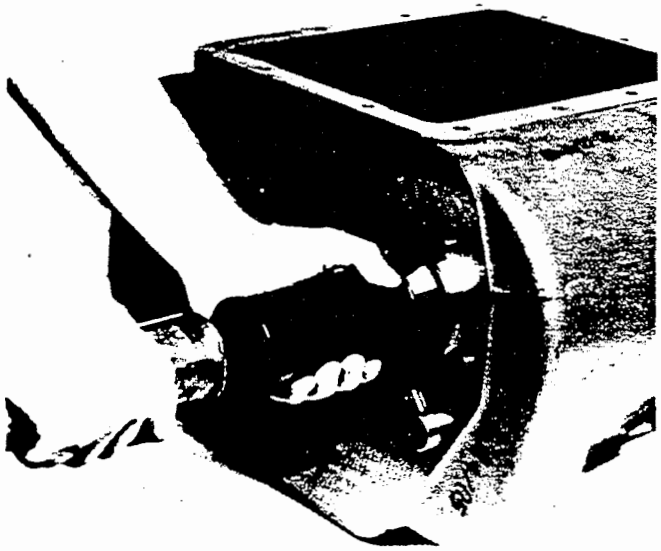


Figure 13-146. Rear Bearing Installation.

NOTE: If damage to original bearing resulted from punch and maul removal, replace with new rear bearing.

6. Shift the mainshaft sliding clutches into all gear positions with a screwdriver. A sliding clutch that cannot be shifted into gear indicates that the drive gear set is out of time. The right countershaft bearings would then need to be removed and the countershaft retimed with the mainshaft. The transmission is properly timed if the sliding clutches can be shifted into all mainshaft gears (figure 13-147).



Figure 13-147. Checking Sliding Clutches.

NOTE: Do not shift the transmission into two gears at the same time. This will prevent the mainshaft and countershaft assemblies from rotating.

7. If properly timed, install both countershaft rear bearing covers with new gaskets and secure to case with capscrews (figure 13-148).

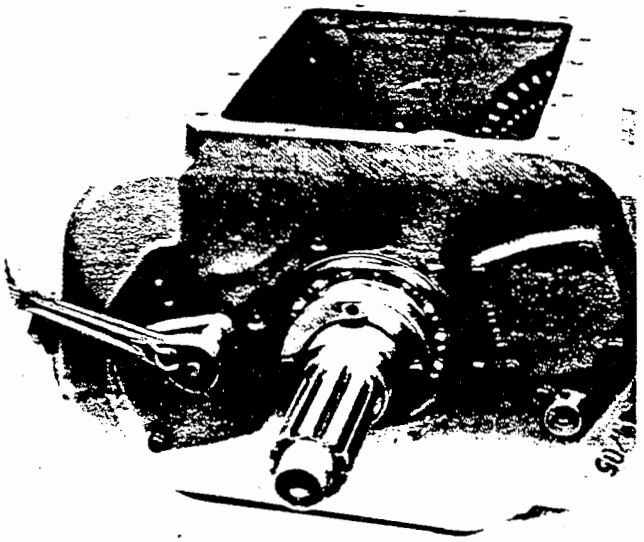


Figure 13-148. Cover Installation.

REASSEMBLY AND INSTALLATION OF LEFT REVERSE IDLER GEAR ASSEMBLY

NOTE: Since the left and right reverse idler gear assemblies are identical, reassembly and installation of the left reverse idler gear assembly should be performed in the same manner as described for right reverse idler gear in previous pages of this section.

COMPLETING INSTALLATION OF MAINSHAFT

1. Remove the temporarily installed output shaft assembly from case bore and coupling gear from rear of mainshaft (figure 13-149).



Figure 13-149. Removing Output Shaft and Coupling Gear.

2. Move the reverse gear to the rear on mainshaft as far as possible, meshing teeth of gear with teeth of the two reverse idler gears (figure 13-150).

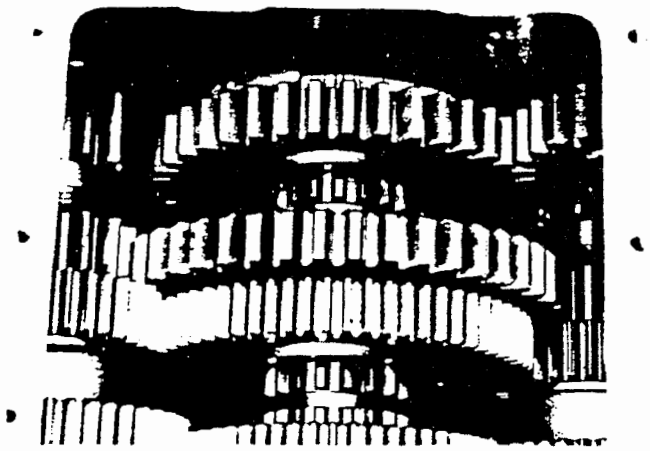


Figure 13-150. Reverse Gear Moved to Rear.

3. With mainshaft forward and reverse gear to the rear, seat the reverse gear spacer previously installed on shaft into hub of gear, and install the retaining ring in I.D. of reverse gear (figure 13-151).



Figure 13-151. Installing Retaining Ring.

COMPLETING REASSEMBLY AND INSTALLATION OF OUTPUT SHAFT ASSEMBLY

1. Install the coupling gear on splines of mainshaft with the counterbore toward the front and keyway aligned with key in shaft (figure 13-152).

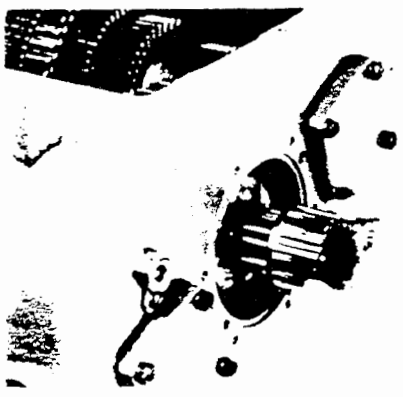


Figure 13-152. Installing Coupling Gear.

2. Install the output shaft assembly over mainshaft, seating bearing in case bore (figure 13-153).

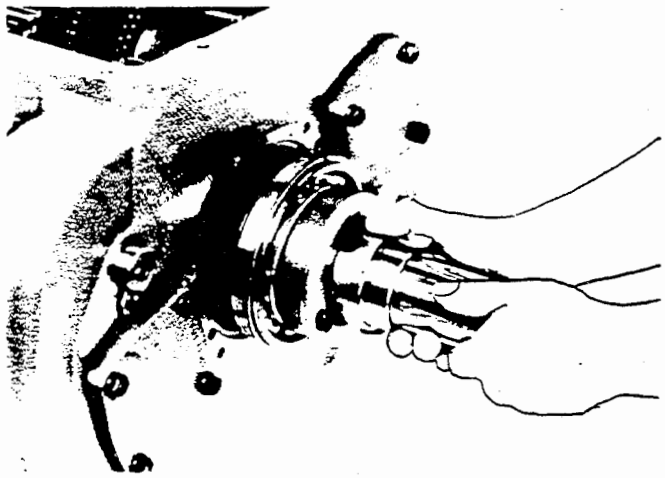


Figure 13-153. Installing Output Shaft Assembly.

CAUTION: Make sure splines in output shaft engage splines of coupling gear.

3. Install the flat keys in bores in output shaft to engage slot in mainshaft (figure 13-154).

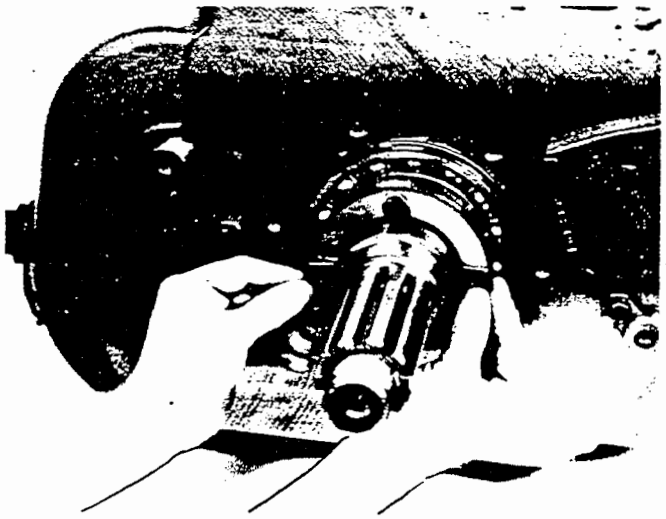


Figure 13-154. Installing Flat Keys.

4. Secure flat keys with 5/16"-24 x 1" capscrews and tighten all capscrews in spacer ring evenly and securely. Install safety wire (figure 13-155).

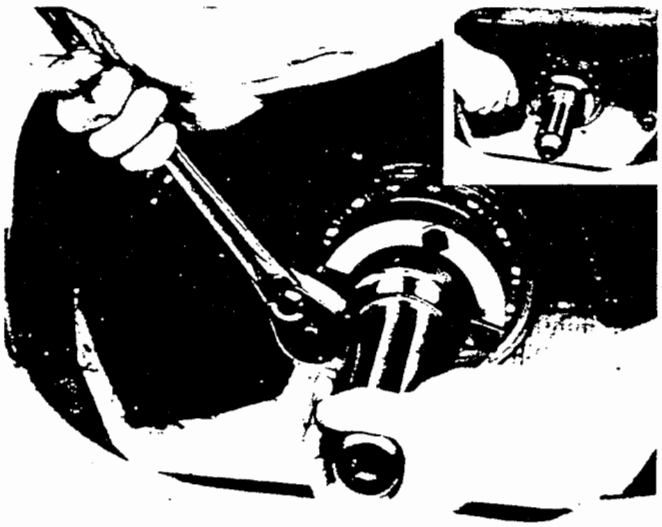


Figure 13-155. Tightening Capscrews.

5. Install outer bearing on output shaft, seating against shaft shoulder (figure 13-156).

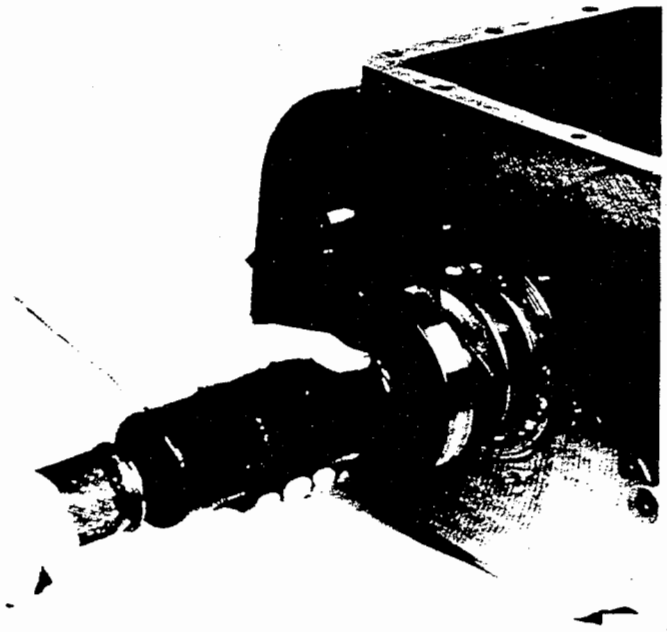


Figure 13-156. Installing Outer Bearing.

6. Install the output shaft bearing washer on shaft and against bearing, chamfered I.D. toward bearing (figure 13-157).

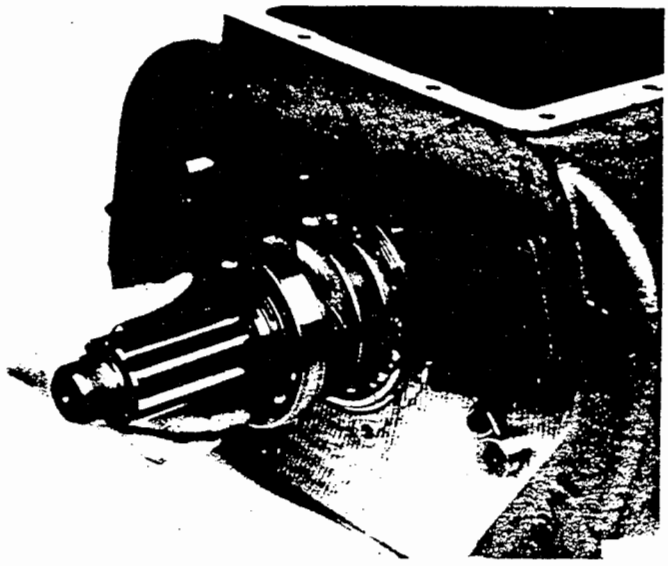


Figure 13-157. Output Bearing Washer Installation.

7. Install the spacer on shaft and against washer (figure 13-158).

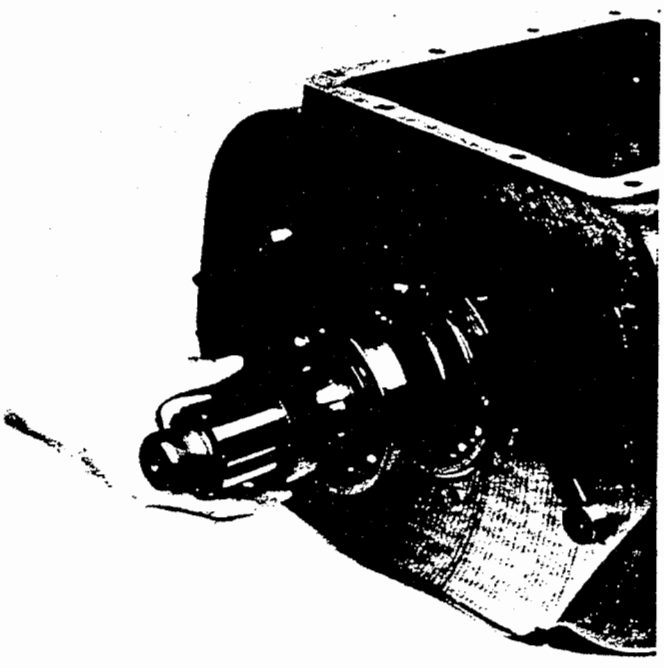


Figure 13-158. Spacer Installation.

MC-9 MAINTENANCE MANUAL

UTCH HOUSING INSTALLATION

1. Apply white grease to new clutch housing gasket and install in position on case (figure 13-159).

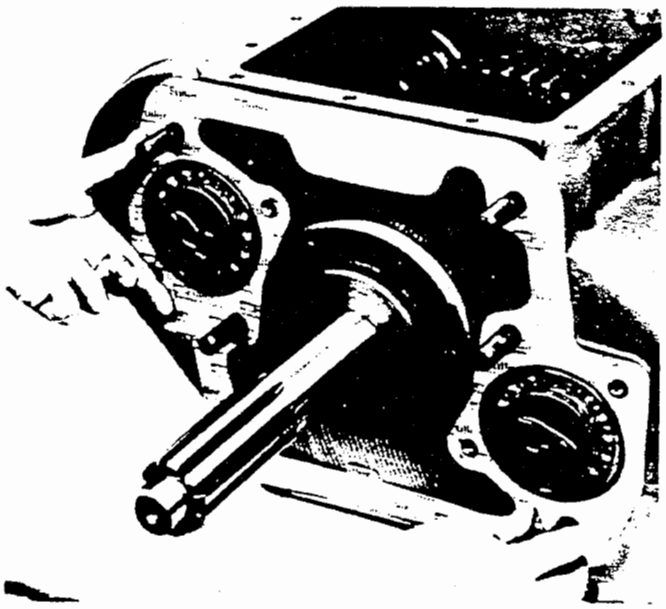


Figure 13-159. Clutch Housing Gasket.

2. Place clutch housing in position on the six studs in front of case, piloting on drive gear cover (figure 13-160).

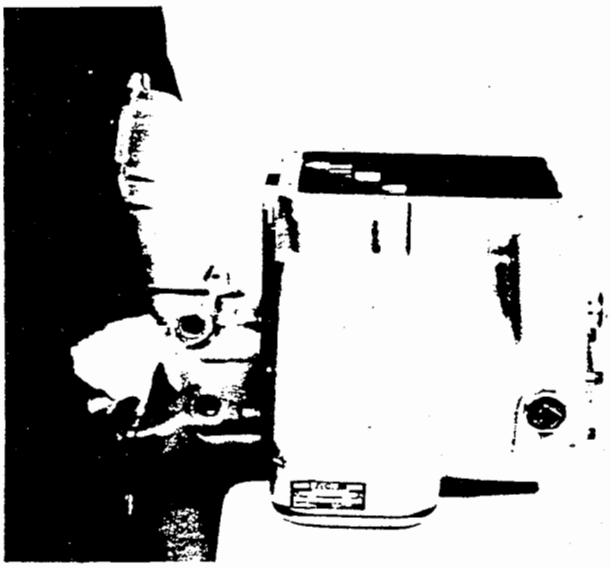


Figure 13-160. Clutch Housing Installation.

3. Install the six nuts on studs with washers or lockwashers and tighten to 180-190 ft. lbs. (244-257 Nm) torque (figure 13-161).

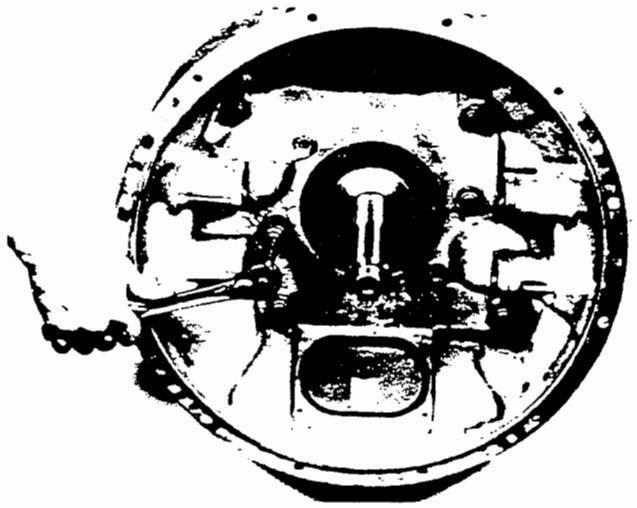


Figure 13-161. Tightening Nuts on Studs.

4. Install the four bolts in clutch housing and tighten to 90-100 ft. lbs. (122-135 Nm) torque (figure 13-162).
5. Install the clutch release mechanism.

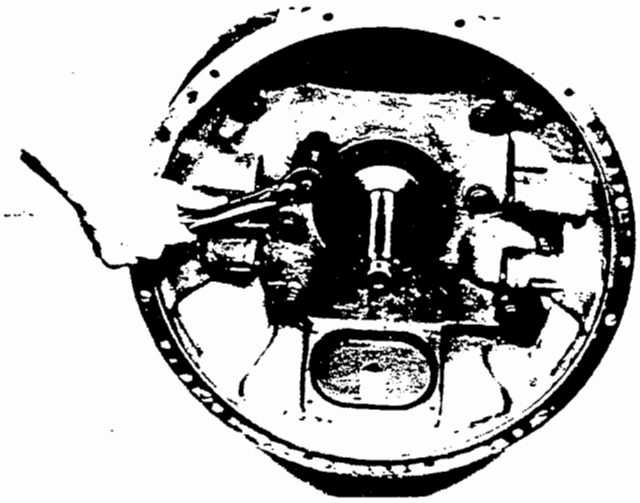


Figure 13-162. Tightening Bolts.

MC-9 MAINTENANCE MANUAL

REASSEMBLY AND INSTALLATION OF REAR BEARING COVER ASSEMBLY

1. Install new oil seal in rear bearing cover if original seal was previously removed. A spring is visible on one side of seal. Install this side with spring toward front of transmission (figure 13-163).

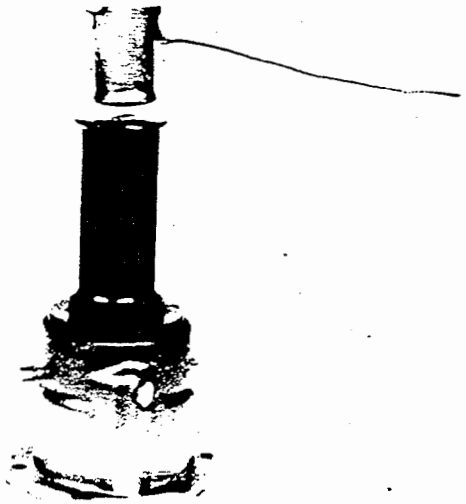


Figure 13-163. Installing Oil Seal.

2. Install rear bearing cover with new gasket evenly on output shaft to seat output shaft bearing in cover, aligning oil slot in cover and gasket with slot in case (figure 13-164).

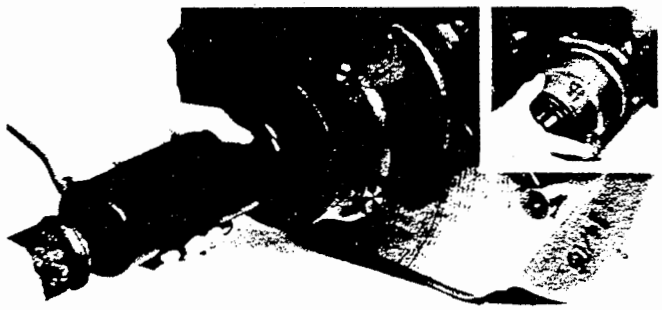


Figure 13-164. Bearing Cover on Shaft.

3. Install attaching capscrews, tighten evenly and securely (figure 13-165).

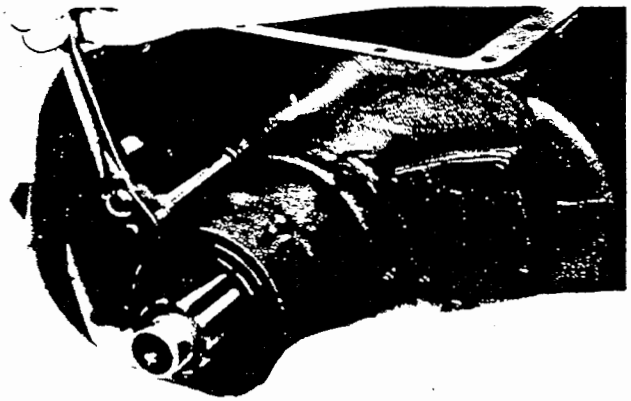


Figure 13-165. Installing Capscrews.

INSTALLING COMPANION FLANGE OR YOKE

1. Lock the mainshaft by engaging two speeds with the sliding clutch gears (figure 13-166).

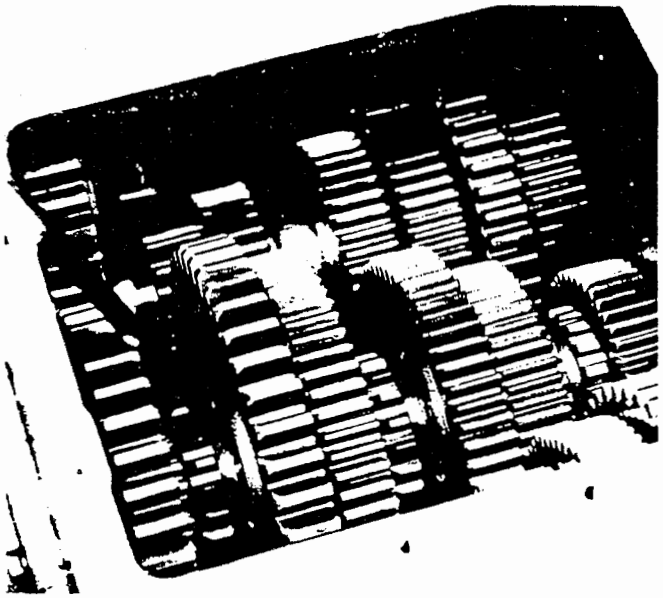


Figure 13-166. Locking Mainshaft.

2. Install flange or yoke on output shaft splines and secure with output shaft nuts, tightening to 400-500 ft. lbs. (542-678 Nm) torque (figure 13-167).

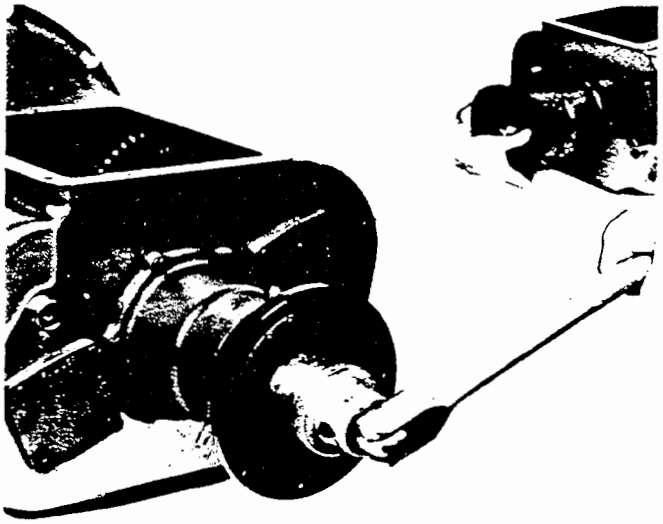


Figure 13-167. Tightening Output Shaft Nut.

ASSEMBLY OF SHIFT BAR HOUSING

1. Install the housing in a vise with the left side up.

NOTE: Shift bars should be installed from the front with neutral and shift notches to the front. Keep bars in the neutral position when installed.

2. Install the long 1st-reverse shift bar in lowest bore in housing, installing the shifting yoke and block on bar, long hub of each to the front (figure 13-168).

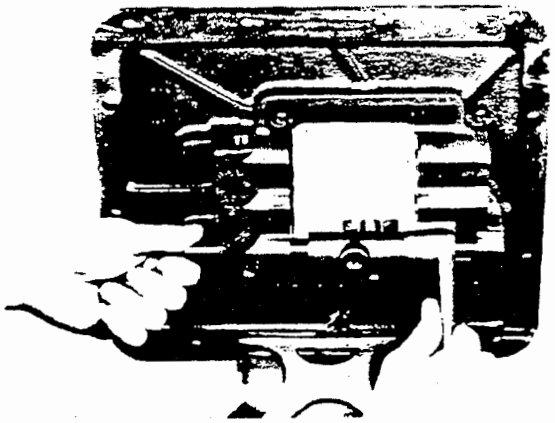


Figure 13-168. Installing 1st-Reverse Shift Bar.

3. Install lock screw in yoke and block, tighten and wire securely (figure 13-169).

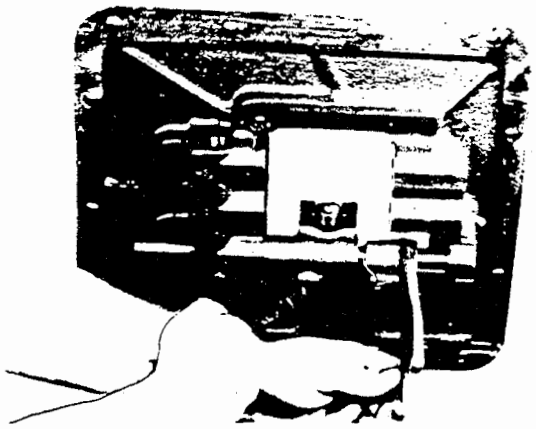


Figure 13-169. Installing Lockscrew.

4. Install ¾" interlock ball in bore in front boss (figure 13-170).

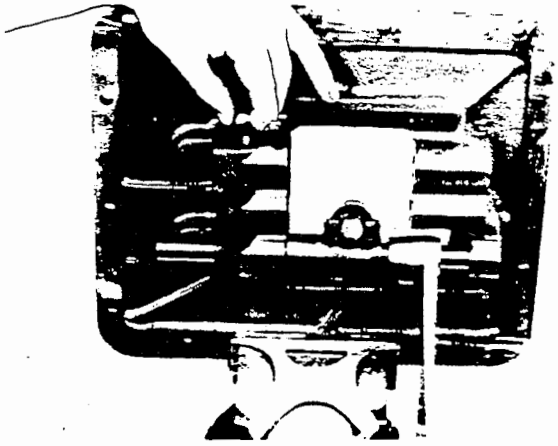


Figure 13-170. Installing Interlock Ball.

5. Install the 2nd-3rd speed shifting bar in center bore in housing and install shift yoke, long hub to the rear. At the same time install interlock pin in bore in neutral notch of bar as notch enters front boss (figure 13-171).

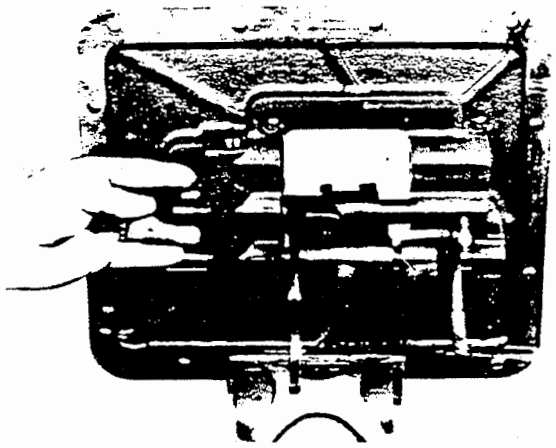


Figure 13-171. 2nd-3rd Shift Bar Installed.

6. Install yoke lock screw, tighten and wire securely (figure 13-172).

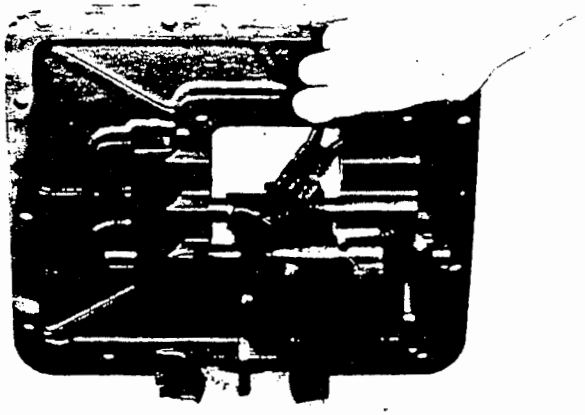


Figure 13-172. Installing Yoke Lockscrew.

7. Install ¾" interlock ball in bore in front boss (figure 13-173).

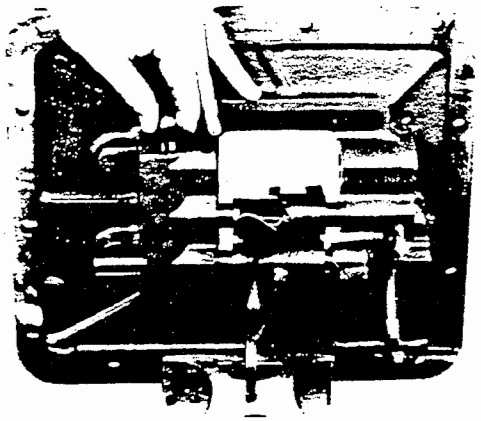


Figure 13-173. Interlock Ball Installation.

8. Install the 4th-5th speed shifting bar in upper bore in housing installing shift yoke on bar, fork to the front (figure 13-174).

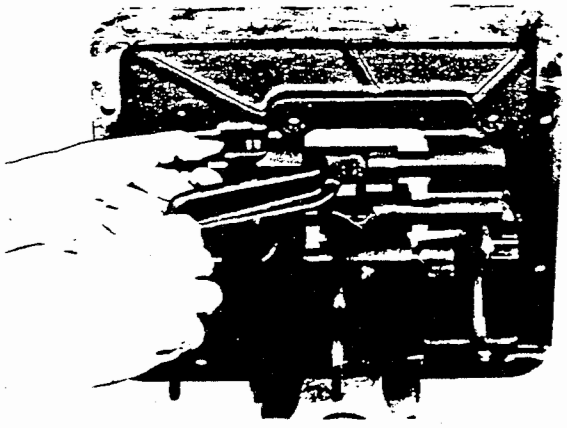


Figure 13-174. 4th-5th Shift Bar Installation.

9. Install yoke lock screw, tighten and wire securely (figure 13-175).

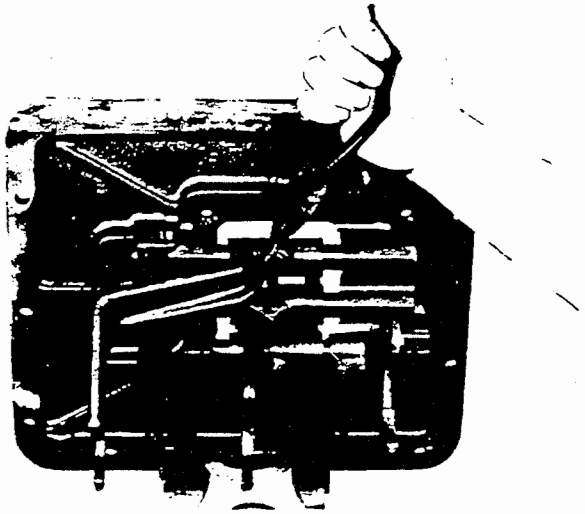


Figure 13-175. Installing Locking Wire.

10. Remove housing from vise and install the three shift bar tension balls in bores in top of housing (figure 13-176).

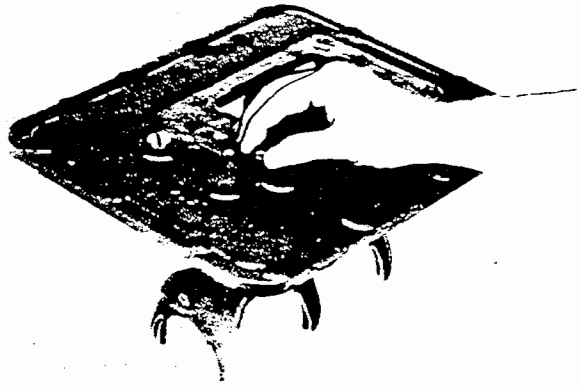


Figure 13-176. Replacing Tension Balls.

11. Install three tension springs in bores (figure 13-177).



Figure 13-177. Replacing Tension Springs.

12. Place a new tension spring cover gasket into position on shift bar housing and install cover. Tighten capscrews to secure (figure 13-178).

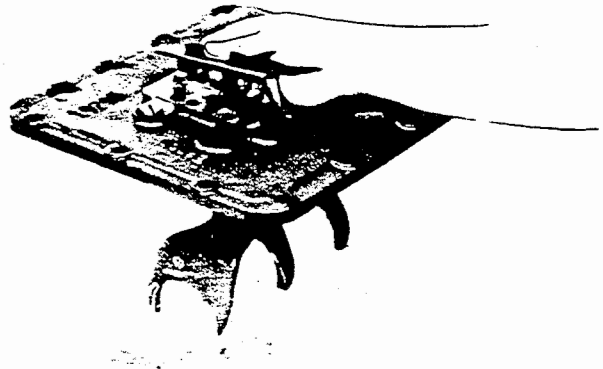


Figure 13-178. Installing Spring Cover.

INSTALLING SHIFT BAR HOUSING

1. Place all three of the sliding clutches in transmission in the neutral position (figure 13-179).

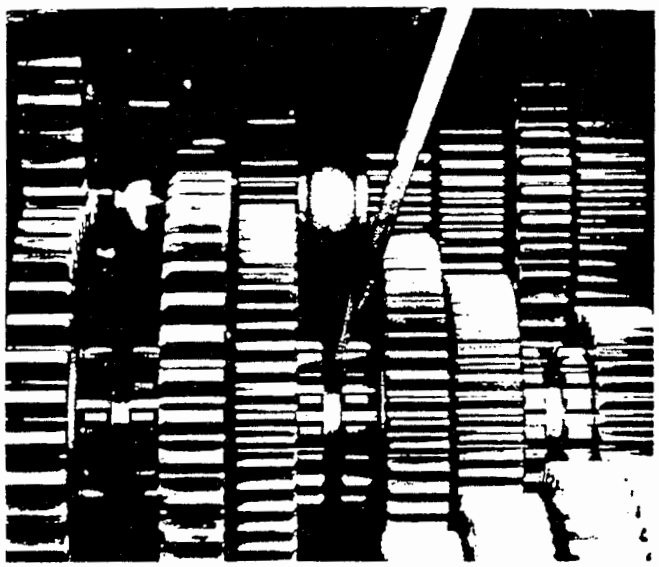


Figure 13-179. Positioning Sliding Clutches.

2. Apply white grease to new shift bar housing gasket and install in position on case (figure 13-180).

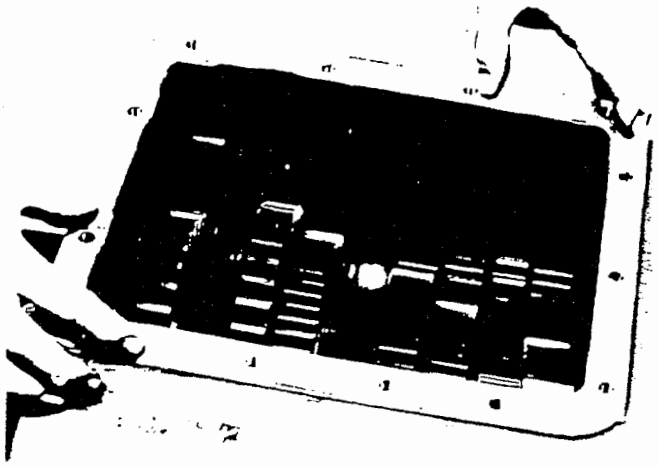


Figure 13-180. Installing Shift Bar Housing Gasket.

3. Make sure shifting bars in housing are in the neutral position (figure 13-181).

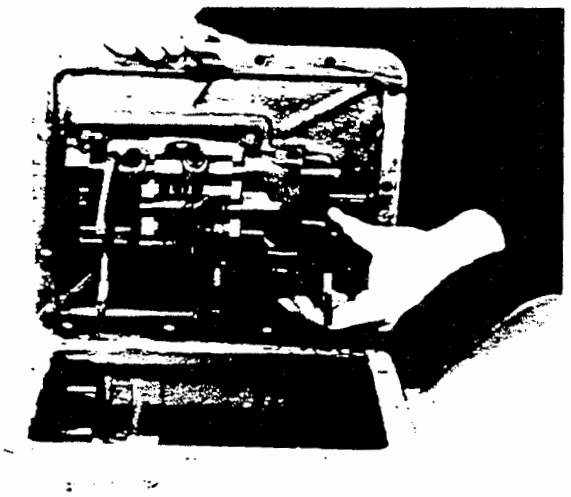


Figure 13-181. Shift Bars in Neutral.

4. Install the shift bar housing on transmission, fitting yokes into corresponding yoke slots of sliding gears, tighten capscrews securely (figure 13-182).

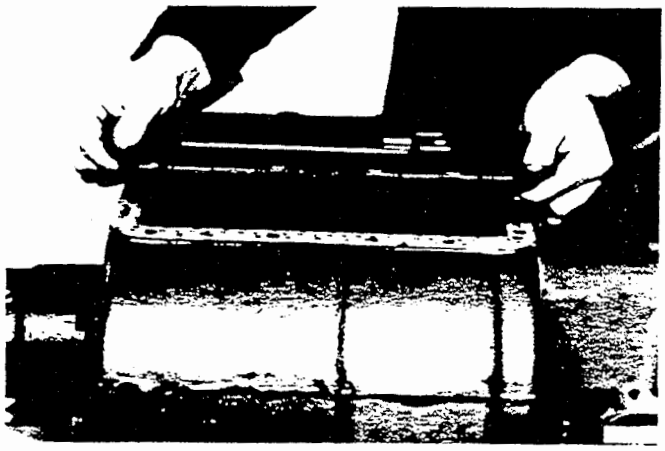


Figure 13-182. Installing Shift Bar Housing.

5. Install the thirteen capscrews in flange holes of housing and tighten, remembering to include the two lifting eyes in position on housing corners opposite each other (figure 13-183).

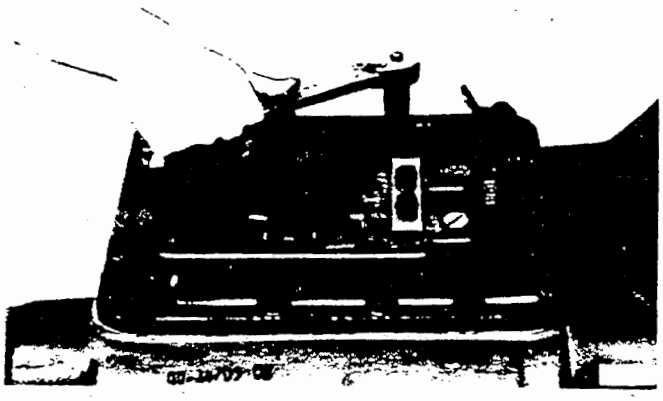


Figure 13-183. Tightening Housing Capscrews.

INSTALLING REMOTE CONTROL AND SHIFTER HOUSING

1. Make sure the shifting notches in the shift bar housing are aligned in the neutral position.
2. Install the shift lever housing, fitting lever into notches in block and yokes; tighten capscrews securely.

5 SPEED TRANSMISSION SHIFT LINKAGE ADJUSTMENT

When adjusting the shift linkage, follow the procedure outlined below to insure that the linkage is set properly for smooth and trouble-free operation.

1. Apply parking brakes.
2. Turn master switch "OFF."
3. Remove turnbuckle at rear shift linkage (figure 13-184).

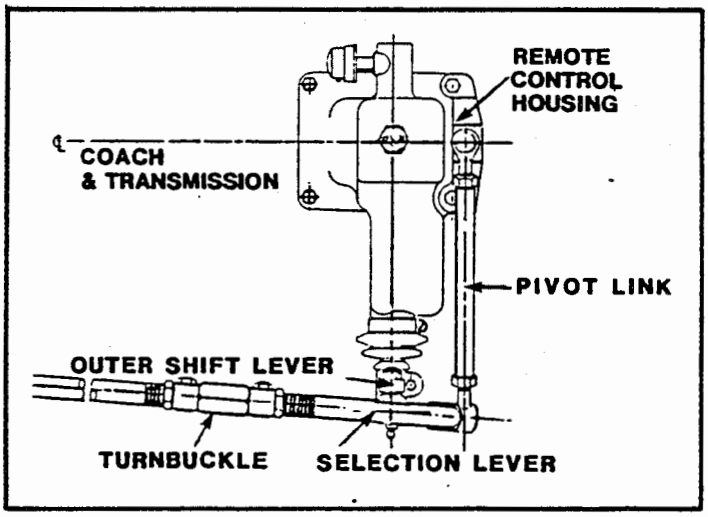


Figure 13-184. Remote Control Shift Linkage Installation.

4. With outer shift lever in vertical position (figure 13-186), find approximate center of free in-and-out movement of inner shift shaft (figure 13-185).

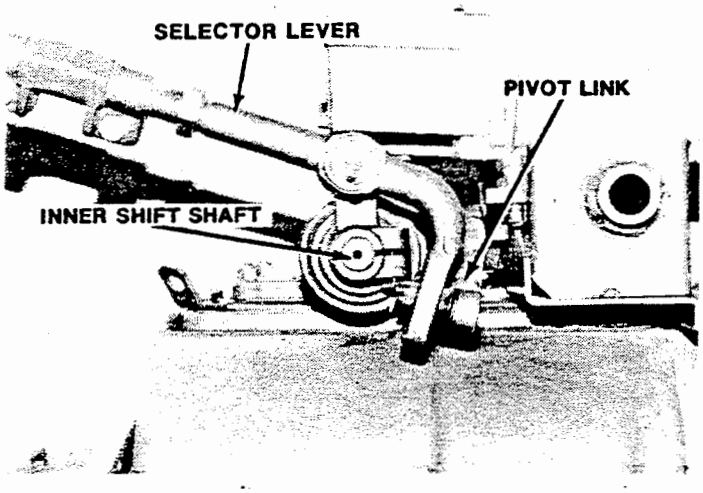


Figure 13-185. Inner Shift Shaft, Selector Lever and Pivot Link.

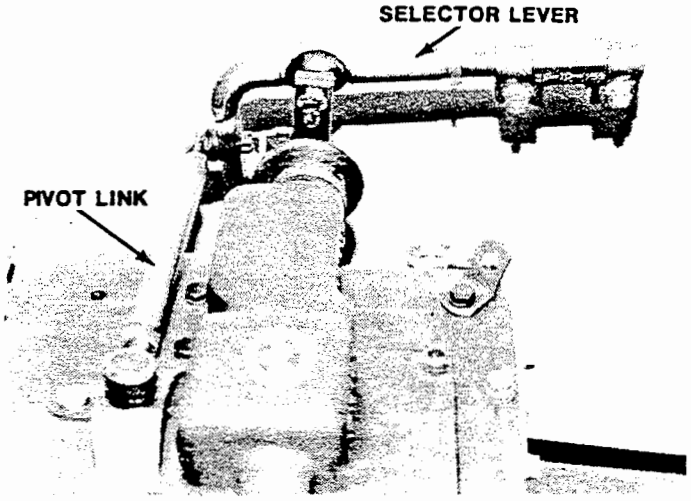


Figure 13-186. Pivot Link and Selector Lever Installation.

5. Maintaining this position, adjust pivot link until bottom end of selection lever is vertical (when viewed from the rear of the coach) and forward end aligns with control rod (figure 13-185).

6. Start turnbuckle on selection lever and rear control rod simultaneously and adjust until proper fore and aft position c gearshift lever (in neutral) is achieved (figure 13-184).

7. Rotate rear control rod to achieve proper side-to-side movement of gearshift lever and secure turnbuckle.

8. "Fine tune" adjustments by lengthening or shortening pivot link if required. Tighten jam nuts and check all shifts for proper interference-free positions (figure 13-186).

MC-9 MAINTENANCE MANUAL

SPEED TRANSMISSION SPECIFICATIONS: STANDARD AND OPTIONAL

Manufacturer	Fuller T-11605D, 11605F
Speeds	5-Forward 1-Reverse
Mounting	On Engine
Gear Selection	Remote Control
Oil Capacity	22 U.S. Pints (10.41 liters)

GEAR RATIOS	T-11605D (Standard)	T-11605F (Optional)
1st	5.46	7.20
2nd	3.23	3.90
3rd	2.05	2.12
4th	1.31	1.46
5th	1.00	1.00
Reverse	5.57	5.57

AXIAL CLEARANCE FOR MAINSHAFT GEARS

Axial Clearance (End Play) limits are:

Reverse speed gear - minimum of .005" (.127 mm)

Forward speed gears - .005"-.012" (.127-.305 mm)

Washers are used to obtain the correct limits and are available in the following thicknesses:

LIMITS	COLOR CODE
.248"-.250" (.630-.635 mm)	White
.253"-.255" (.642-.647 mm)	Green
.258"-.260" (.655-.660 mm)	Orange
.263"-.265" (.668-.673 mm)	Purple
.268"-.270" (.680-.685 mm)	Yellow
.273"-.275" (.693-.698 mm)	Black

Refer to Parts Manual for washer part numbers

Always use the .248"-.250" (.630-.635 mm) low limit washer (White) in the 1st and 3rd speed gear positions.

TORQUE SPECIFICATIONS

NUTS

Clutch Housing to Case	180-190 ft. lbs. (244-257 Nm)
Drive Gear Bearing Nut	250-300 ft. lbs. (339-407 Nm)
Output Shaft Front Bearing Nut	250-300 ft. lbs. (339-407 Nm)
Companion Flange Nut	400-500 ft. lbs. (542-678 Nm)

CAPSCREWS*

Clutch Housing to Case	90-100 ft. lbs. (131-136 Nm)
Countershaft Front Bearing Retainer	20-25 ft. lbs. (27-34 Nm)
Output Shaft Key Spacer Ring	20-25 ft. lbs. (27-34 Nm)
Output Shaft Key	20-25 ft. lbs. (27-34 Nm)
Front Bearing Cover	35-45 ft. lbs. (47-61 Nm)
Shiftbar Housing	35-45 ft. lbs. (47-61 Nm)
Mainshaft Rear Bearing Cover	35-45 ft. lbs. (47-61 Nm)
Countershaft Rear Bearing Covers	35-45 ft. lbs. (47-61 Nm)
Reverse Idler Shaft Lock	25-35 ft. lbs. (34-47 Nm)

* Do not torque capscrews dry

MC-9 MAINTENANCE MANUAL

AUTOMATIC TRANSMISSION

Detailed service procedures for the Allison HT700 Series automatic transmissions may be found in the applicable DDA Transmission Service Manuals.

CHANGING OIL FILTER

1. Remove filter element by rotating counterclockwise. (See figure 13-187.)

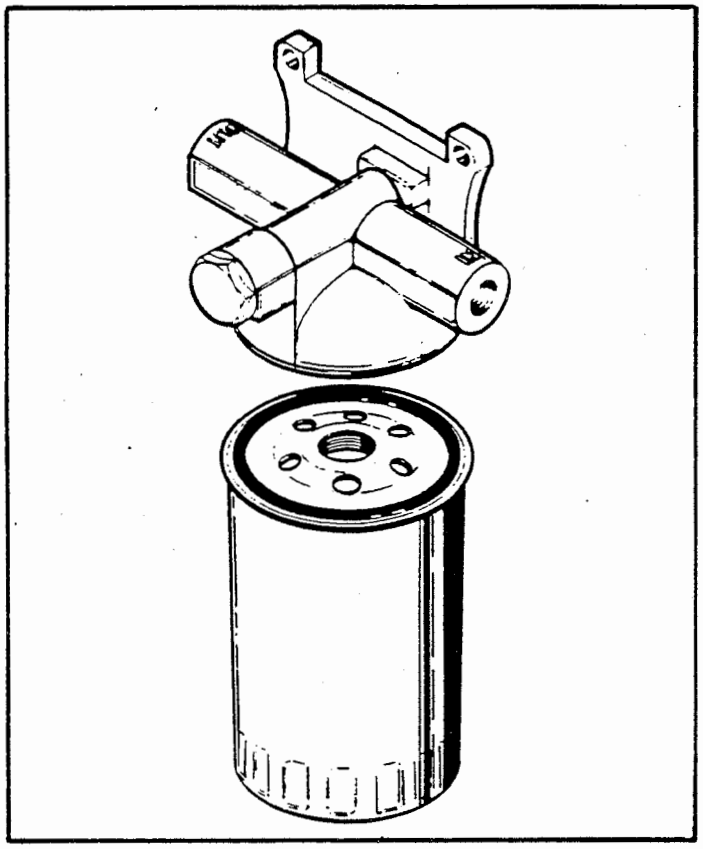


Figure 13-187. Automatic Transmission Filter.

2. Discard element.

3. Thoroughly clean any dirt or oil from the base casting.

4. Install new element. Tighten element 2/3 turn after element seal first contacts the base.

5. Run the engine and check for leaks.

6. Check the transmission oil level and add "Dexron II" fluid if required.

MODULATOR VALVE INSTALLATION (6V-92, 8V-71 & 8V-92 ENGINE AND HT740 TRANSMISSION)

1. Remove plastic plug from transmission and plastic cap from modulator valve (if so equipped). Make certain modulator valve spacer pin which is supplied with the transmission is in place. Ensure that the O-ring (11) is in place on the shaft of the valve. Refer to figure 13-189.

2. Lubricate shaft with Dexron II transmission fluid. Insert shaft of modulator valve into hole in transmission.

3. The actuator is retained by a flat spring clip and bolt which are provided with the transmission. Place retaining clip in groove on shaft of actuator and tighten bolt to 15-20 ft. lbs. (20-27 Nm) torque.

4. Route cable and secure to pivot arm on governor.

5. Rotate the governor pivot lever to the full throttle position.

6. Pull the cable until it is internally bottomed. Adjust trunnion on end of cable to permit a "free pin" with fuel control lever in full fuel position. Install and secure pin.

7. Check linkage for proper return to idle position. Check cable for proper travel; should be approximately 1.187" minimum (30.162 mm) to 1.56" maximum (39.62 mm).

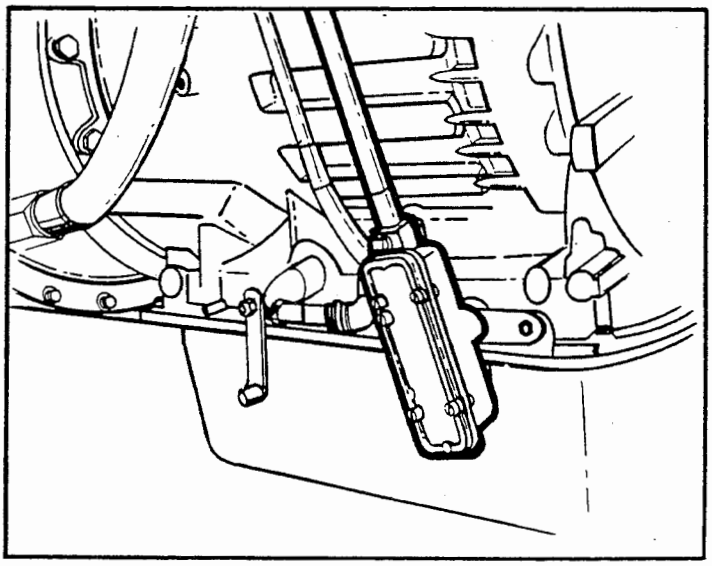
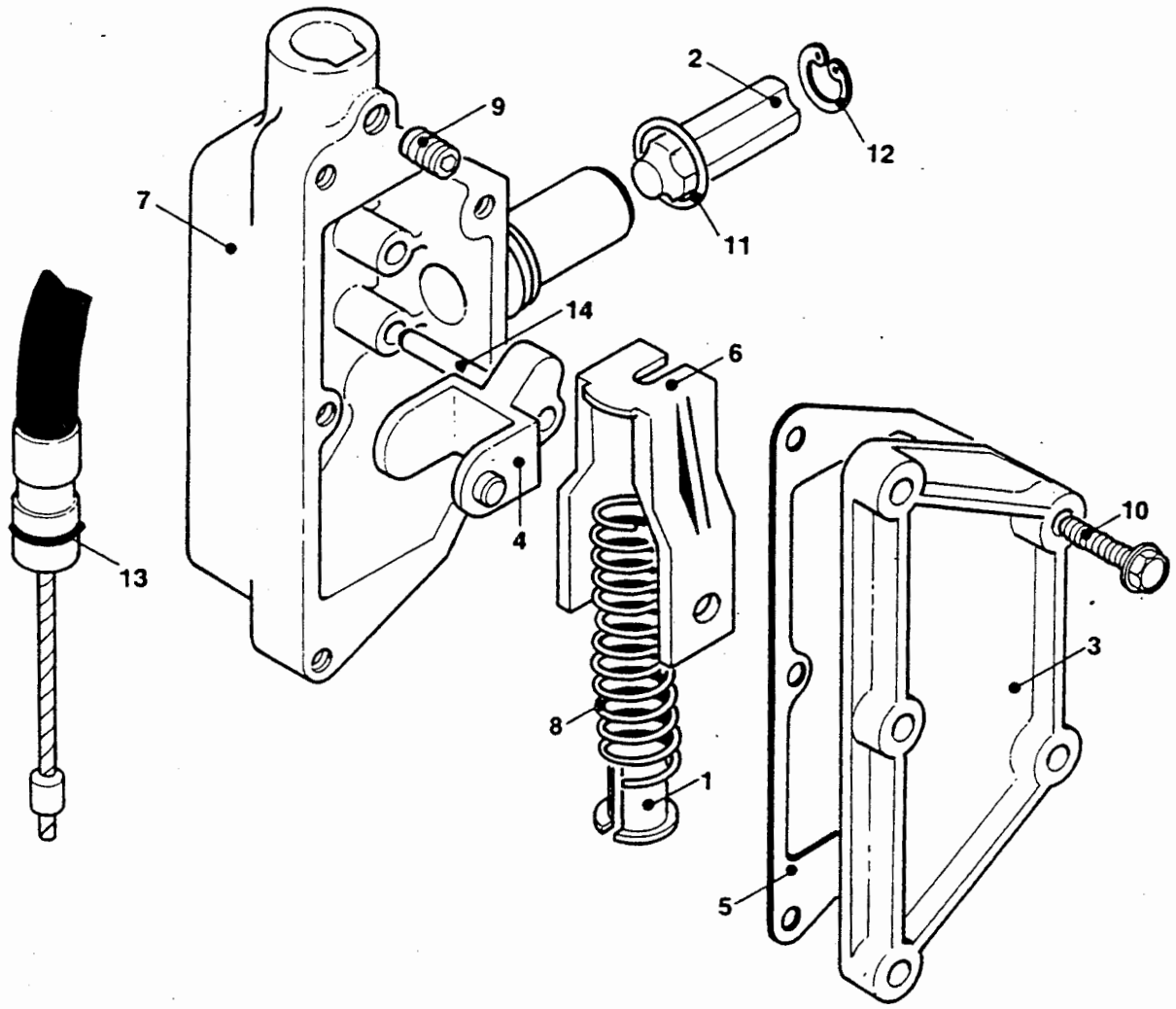


Figure 13-188. Modulator Valve Installed.

MC-9 MAINTENANCE MANUAL



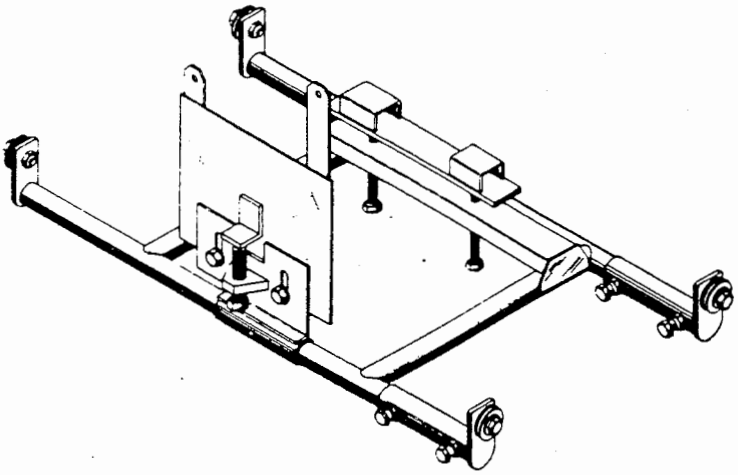
1. Thimble
2. Plunger
3. Cover
4. Lever
5. Gasket
6. Spring Retainer
7. Housing
8. Spring
9. Set Screw
10. Capscrew
11. O-ring
12. Retaining Ring
13. O-ring
14. Dowel Pin

Figure 13-189. Modulator Valve (HT-740 Transmission With 6V-92 or 8V-71 Engine).

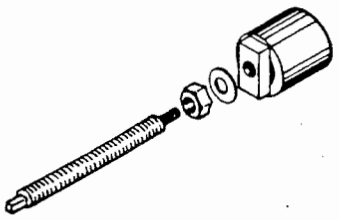
MC-9 MAINTENANCE MANUAL

SERVICE TOOLS

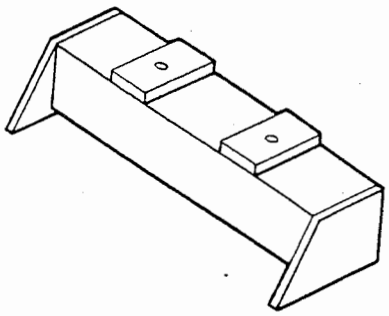
SOME OF THE TOOLS USED FOR THE MAINTENANCE PROCEDURES OUTLINED IN THIS SECTION ARE NONSTANDARD. THEY ARE, HOWEVER, AVAILABLE FOR PURCHASE FROM MOTOR COACH INDUSTRIES, TRANSPORTATION MANUFACTURING CORPORATION AND UNIVERSAL COACH PARTS. WHERE PRACTICAL, THEY MAY BE FABRICATED BY THE SERVICE FACILITY.



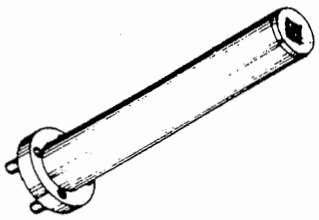
20-233 Transmission Dolly



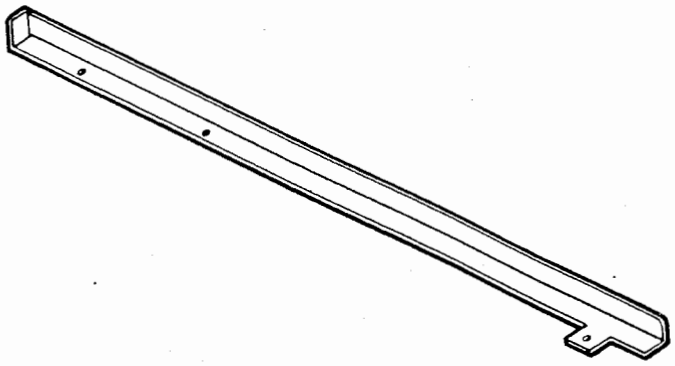
20-42 Puller — Removing Transmission Reverse Idler Gear Shaft



20-234 Transmission Adjusting Channel



20-43 Wrench — Assembling Bearing Retaining Nut on Transmission Main Drive Gear (use with 20-79)



20-235 Support Rail - L.H. - Transmission Dolly

20-236 Support Rail - R.H. - Transmission Dolly



20-79 Adapter — Transmission Drive Gear, Lock Nut Installation Tool

Date 1-1-89

MC-9 MAINTENANCE MANUAL

SECTION 14

PROPELLER SHAFT

SUBJECT	PAGE
Cleaning and Inspection	14-2
Disassembly of Universal Joints	14-2
Drive Shaft Assembly	14-3
Lubrication	14-2
Maintenance	14-1
Reassembly	14-2
Relube Cycles	14-3
Removal	14-1
Specifications	14-4
Troubleshooting	14-4
Universal Joints	14-2
Service Bulletin Page	

MC-9 MAINTENANCE MANUAL

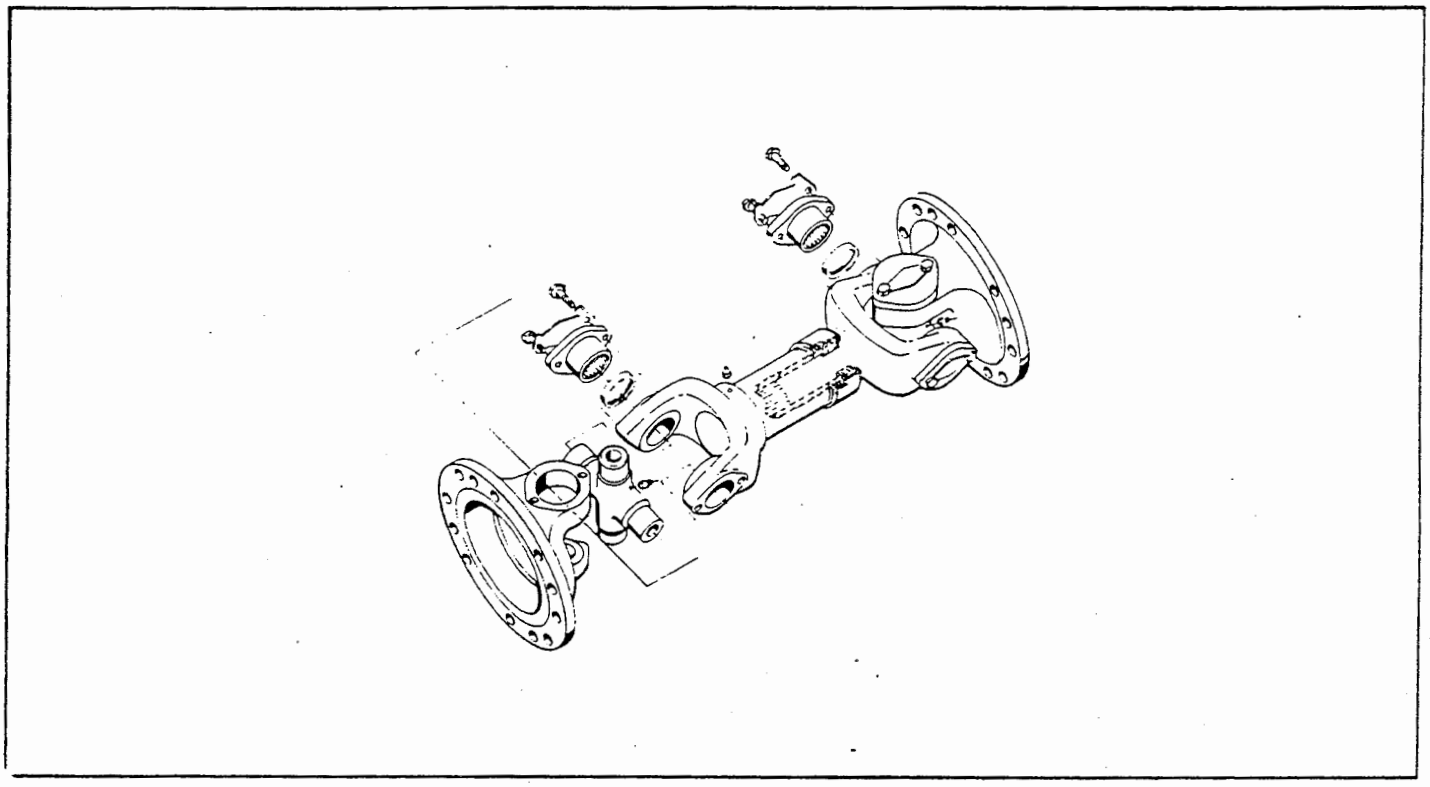


Figure 14-1. Coach Propeller Shaft

PROPELLER SHAFT

The propeller shaft transmits power from the transmission to the differential. In the two-axle coach, this is done through the use of an intermediate drive adapter (drop box). The propeller shaft is of the tubular type and uses two heavy duty needle bearing universal joints.

The slip joint compensates for variations in distance between the transmission and differential or drop box brought about by the rise and fall of the rear axle as the coach passes over uneven surfaces. The slip joint also facilitates removal of the transmission or rear axle.

The propeller shaft is flanged at each end for attachment to the transmission and differential (Fig. 14-1).

CAUTION: When assembling the propeller shaft to the sleeve yoke, the arrows must align at the joining areas. This will align the trunnions.

MAINTENANCE

Both universal joints are provided with lubrication fittings. A third lubrication fitting is provided at the slip joint.

The propeller shaft lubrication fittings should be serviced according to the recommendations contained in Section 10 of this manual.

Shaft flanges should be checked at regular inspection intervals for loose or broken bolts, lockwashers and nuts. When installing bolts, use only new ⅜" (9.52 mm) spring lockwashers to provide a proper lock.

CAUTION: Do not re-use lockwashers in this location. On coaches with standard transmission, only 14B-1-28 bolts are to be installed as they are Grade 8 bolts with a longer than normal unthreaded section as shown in Figure 14-2.

It is important that only (19-3-162) grade 8 hex nuts are installed on these bolts. The recommended torque value for the hex nuts is 35-39 ft. lbs. (47-53 Nm).

REMOVAL

The propeller shaft may be removed from the vehicle by removing the bolts which attach the universal joint flange and flange or end yoke to the differential and transmission shafts.

To remove the propeller shaft, remove the nuts and lockwashers which attach the propeller shaft flange and flange or yoke to transmission and differential shafts. Unscrew the slip joint dust cap. Telescope the propeller together at the slip joint. The shaft can then be removed. Replacement is the reverse of removal.

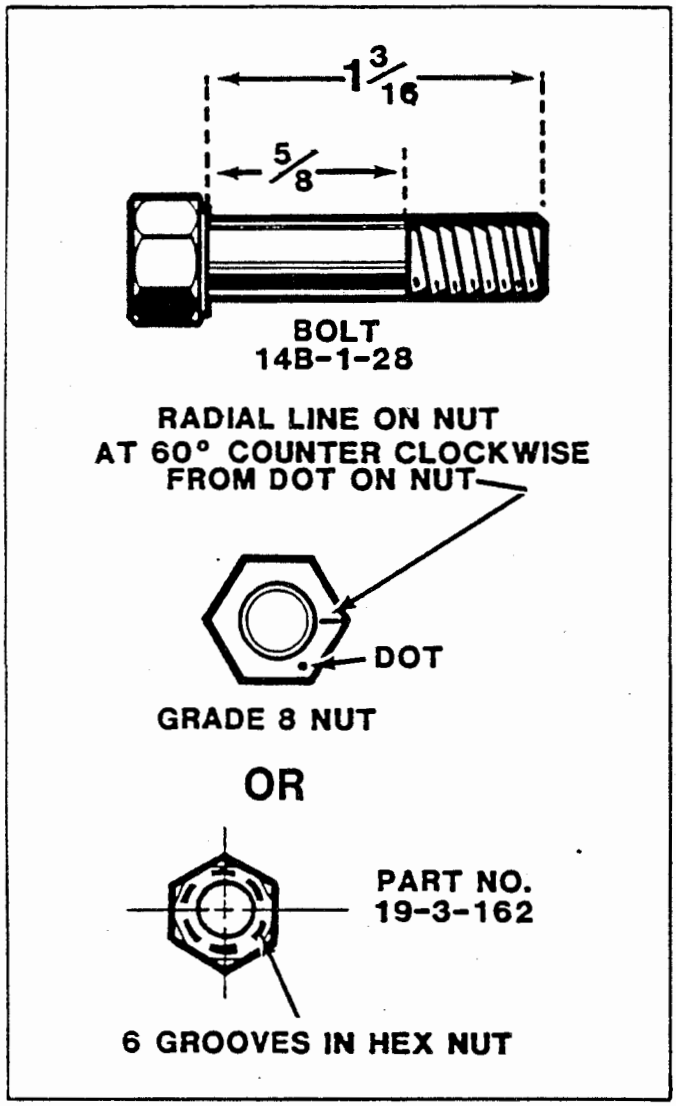


Figure 14-2. Propeller Shaft Flange Bolts and Nuts.

DISASSEMBLY OF UNIVERSAL JOINTS

Bend tangs of lock plate. Unscrew capscrews and remove lock plate. To remove the needle bearings and retaining cap subassembly use a large pair of channel lock pliers on retaining cap edges, turn retaining cap and bearing subassembly at the same time lifting upward to remove the subassembly from the journal trunnion diameter and out of the yoke hole. Turn the joint over and tap the exposed end of the journal cross until the opposite needle bearing is free. Use a soft round drift with flat face about 1/32" (.79 mm) smaller in diameter than the hole in the yoke.

Remove the journal cross by sliding it to one side of the yoke and tilting it over the top of the yoke lug.

CLEANING AND INSPECTION

Thoroughly clean grease from bearings, journals, and other parts. Clean all lubricant passages in the journal, and the lubrication fittings. Needle bearing assemblies may be soaked in cleaning solution to soften particles of hard grease. It is extremely important that bearing assemblies be absolutely clean, since even very small particles of dirt or grit can cause rapid bearing wear. Do not attempt to disassemble needle bearings.

Bearing journal areas should be inspected for roughness or grooving. If light honing does not remove roughness, the entire bearing assembly should be replaced. Excessive wear of the needle bearings is indicated if the needles drop out of the retainer, or if marks are present on the journal bearing surface.

Inspect yokes for cracks, wear or distortion.

REASSEMBLY

Pack needle bearing assemblies with clean grease. Insert one trunnion of the journal into the yoke as far as possible from the inside, and tilt until opposite trunnion clears the yoke and drops into position. Install lubrication fittings and lubricate bearings approximately 1/3 full with the lubricant specified in Section 10.

Insert bearing assemblies from outside of yoke and tap into place with plastic hammer. Do not use a steel hammer for this purpose. The joints should move freely in the bearings and not bind. Also, if new needle bearing assemblies are not being installed, care should be taken to replace bearing assemblies in the same locations from which they were removed. Install bearing caps, new lock straps, and capscrews. Tighten capscrews firmly then lock screws by bending lock straps against screw heads.

LUBRICATION

UNIVERSAL JOINTS

To insure proper lubrication of all four bearing assemblies on universal joints, it is essential to add lubricant until it appears at all journal cross bearing seals. See figures 14-3 thru 14-6. This assures removal of dirt particles and other contaminants that may find their way into the bearings and indicates that the bearings are fully lubricated.

Do not assume that bearing cavities have been filled with new lubricant unless flow is noticed around all four bearing seals.

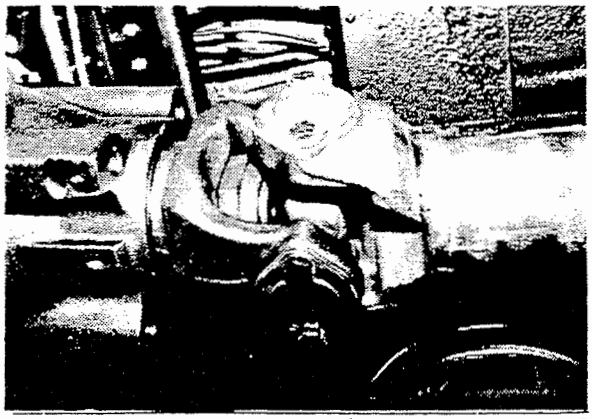
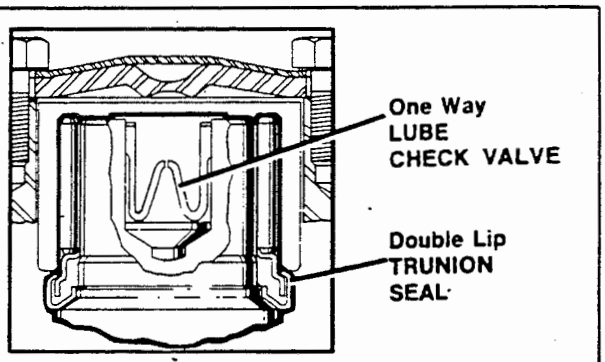


Figure 14-3. Propeller Shaft Grease Nipples and Mounting Bolts.

MC-9 MAINTENANCE MANUAL

Journal cross seals are designed to relieve. However, if all the seals do not "pop" when being lubed, move the driveshaft laterally in all four directions and pull or push on the driveshaft in the direction opposite to the journal cross seal not relieving while lube gun pressure is being applied to the alemite fitting. An increase in line pressure may also be necessary.

If seals fail to purge, cup removal may be necessary to remove the obstruction and promote lubrication.



Identifying features
Seal — Double lip pressed in bearing assembly.
Lube Check Valve in journal cross lube reservoir cavities.

Figure 14-4. Seal Cross Sectional View.

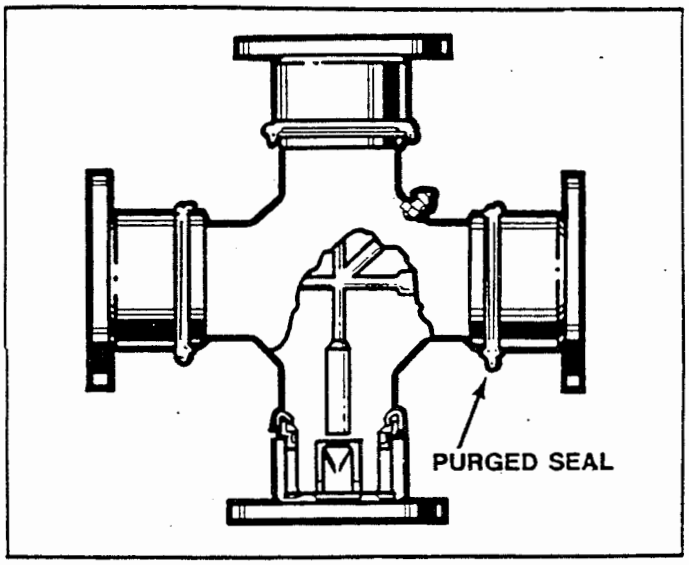


Figure 14-5. Journal Cross Assembly.

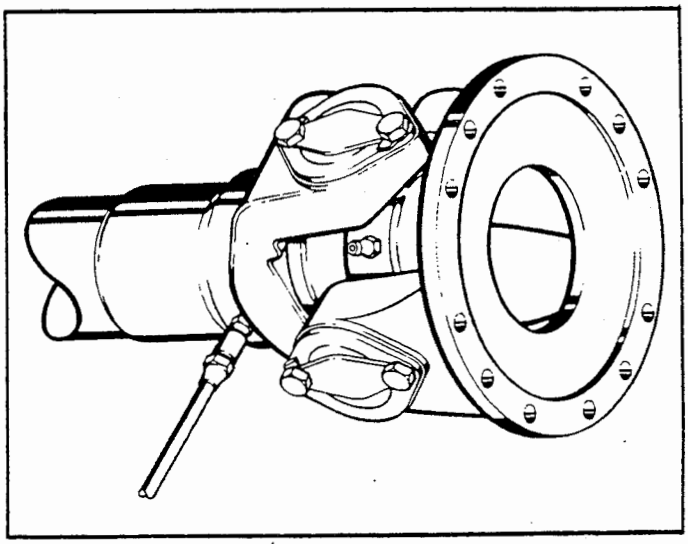


Figure 14-6. Sleeve Yoke End of Spline.

DRIVE SHAFT ASSEMBLY

Factory assembled drive shafts are lubricated at the plant prior to shipment. When installing spare parts replacement assemblies, it is recommended that all universal joints be lubricated after installation of the drive shaft prior to putting vehicle in service. High quality extreme pressure (EP) grease is recommended for universal joints. Lithium soap base greases meeting NLGI Grade 1 and Grade 2 specifications are preferred. The use of greases that tend to separate and cake should be avoided. Refer to Section 10 for lubrication intervals.

RELUBE CYCLES

Relubrication cycles for drive shaft universal joints and slip splines vary with operating conditions. The following relubrication schedule has been used successfully.

	Miles	Kilometers	Hours
Normal	6,000-8,000	9,700-13,000	150-200
*Severe	2,000-3,000	3,200- 4,800	50- 75

*Such as high ambient temperatures or extremely rough road conditions.

TROUBLESHOOTING

Noise and vibration in the drive line often originate in the propeller shaft. Noise and vibration originating in the universal joint and propeller shaft assembly appear only at certain speeds, and usually come and go as the vehicle speed is increased or decreased. Noises produced by the rear axle, on the other hand, are generally present throughout the vehicle's speed range.

When propeller shaft assembly noise and vibration becomes excessive, the cause should be determined and corrected immediately, since rear axle pinion failure is often a direct result. Propeller shaft noise and vibration often appear to originate in the rear axle.

Common causes of propeller shaft and universal joint vibration are (a) propeller shaft assembly out of balance; (b) excessive flange runout or distorted yokes; (c) loose yoke nuts; (d) universal joint yoke misalignment.

If an out-of-balance condition is suspected, the assembly may be tested using a balancing machine. If a balancing machine is not available, the check may be made of each component of the assembly individually on the vehicle. Substitute one component at a time, road testing as each new part is installed. Continue this procedure until the entire assembly meets the required standard of performance.

SPECIFICATIONS

PROPELLER SHAFT OVERALL, UNINSTALLED, CROSS TO CROSS COLLAPSED LENGTH

Engine	Transmission	Cross to Cross Collapsed Length	Type of Connection	TMC/MCI Part No.
6V-92TA	T-11605D or T11605F	30.00	Flange	14G-1-6
6V-92TA	HT-740; HT-741; HT-748	21.00	Flange	14G-1-4
6V-92TA	HT-754, HT-755	17.00	Flange	14F-1-11
8V-92TA	T-11605D or T11605F	23.03	Yoke	14J-1-14
8V-92TA	HT-740; HT-741; HT-748	15.56	Yoke	14J-1-16
8V-92TA	HT-754, HT-755	13.00	Yoke	14G-1-9
8V-71	HT-740	15.29	Flange	14J-1-32
8V-71	HT-754	13.50	Flange	14G-1-1
8V-71	T-11605D, T11605F	23.00	Flange	14G-1-19

OVERALL JOINT SERIES

Slip Joint & Fixed Joint - HT-740D & HT-747D Auto. Trans. & 11605D Manual Transmission 1710

Slip Joint & Fixed Joint - 8V-92 & HT-754 Transmission 1810

BEARING ROLLERS

Type (1710 or 1810) ..... Needle

Number (1710 or 1810) 36

Spline O.D. (1710) ..... 2.50" (63.5 mm)

Spline O.D. (1810) ..... 3.00" (76.2 mm)

Spline Length (1710) ..... 4.00" (101.6 mm)

Spline Length (1810) ..... 4.00" (101.6 mm)

Date 1-1-89

MC-9 MAINTENANCE MANUAL

SECTION 15

WHEELS HUBS AND TIRES

SUBJECT	PAGE
Drive Wheels	15-7
Front and Trailing Wheels	15-6
Manual Demounting and Mounting of Tires	15-5
Oil Seal Installation	15-8
Safety Precautions	15-3
Service Tools	15-10
Specifications	15-10
Tires	15-3
Service Bulletin Page	

MC-9 MAINTENANCE MANUAL

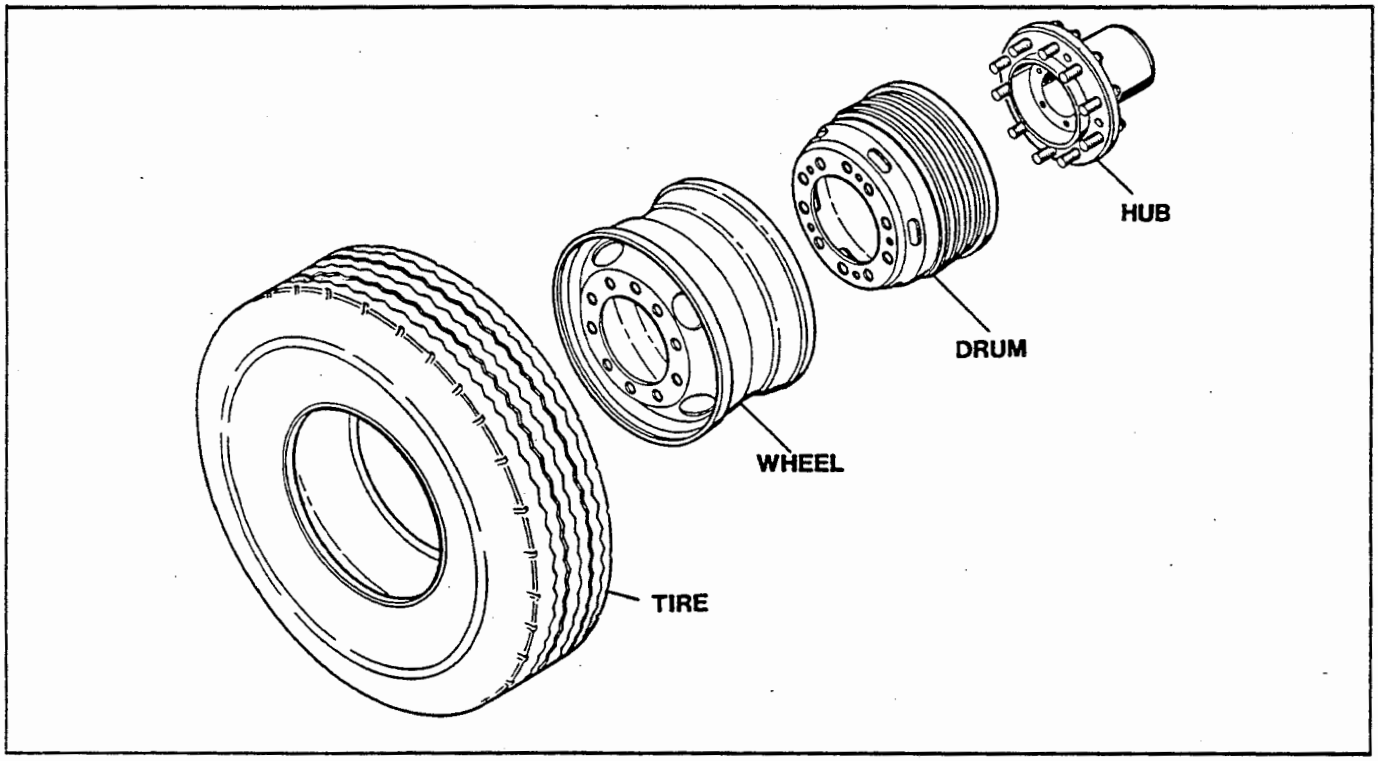


Figure 15-1. Tire, Wheel, Drum and Hub.

WHEELS, HUBS AND TIRES

Wheels supplied on the coach vary according to the specifications of the user. They are of standard type and manufacture and may have either 2-piece or 3-piece rims. Either tube type or tubeless tires may be used.

Standard wheels are 22.50 x 8.25" (571.5 x 209.5 mm) for tires of the following sizes: 12.00" x 22.50" (304.8 x 571.5 mm), 12.5" x 22.5" (317.5 x 571.5 mm) or 12.75R x 22.5 (323.9 x 571.5 mm). See figure 15-1.

The spare wheel and tire are carried in a compartment immediately behind the front bumper. Access is gained by releasing retaining locks located directly beneath the bumper, then pulling bumper out and up. Bumper will lock in the open position. Make sure that both bumper locks are firmly in place after closing compartment door.

WHEEL MAINTENANCE

Maintenance consists of periodic checks to see that wheel nuts are tightened to the proper torque. With a new coach, or after new wheels have been installed, stud nuts should be tightened every 100 miles (161 km) for the first 500 miles (805 km) to allow setting in of clamping surfaces.

Standard equipment consists of stud-mounted wheels; hub-mounted wheels are optional.

Stud-mounted wheels rely on the cone-shaped wheel nuts to hold the wheel on the hub in the proper location. After July '85, all 96/102 series coaches have, on the front axles, five cone-shaped wheel nuts and five flanged wheel nuts, installed alternately. Rear and trailing wheels have only the cone-shaped wheel nuts.

When installing front wheels (stud-mounted) always install and tighten the cone-shaped wheel nuts first to properly center the wheel. Tighten the nuts progressively, on alternate sides of the wheel. Final tightening should be with a torque wrench to 450-500 lb-ft (610-678 Nm) torque. The torque requirement is for both the cone-shaped and the flanged wheel nuts.

> **CAUTION: Do not intermix stud-mount nuts with nuts used on hub-mounted wheels. Stud-mounted wheels must be installed with cone-shaped and flanged stud nuts. Rear and trailing axle stud-mounted wheels must be installed with the cone-shaped stud nuts.**

Hub-mounted wheels (optional equipment) are mounted with a close tolerance fit of the wheel over the axle hub flange.

The nuts used with hub-mounted wheels are flat. Cone-shaped or flanged nuts are not used with hub-mounted wheels. the nuts are to be tightened progressively on alternate sides of the wheel. Final tightening should be with a torque wrench to 450-500 lb-ft (610-678 Nm) torque.

> **CAUTION: Do not intermix stud nuts for hub-mounted wheels with those intended for use with stud-mounted wheels. Do not use stud-mount wheels in place of hub-mount wheels. Do not adapt either type of wheel for a different mounting.**

Wheel studs and nuts must be kept free from grease and oil. No lubricant should be used, except for the cap nut condition described below.

MC-9 MAINTENANCE MANUAL

Corrosion or galling of the stud and nut assembly can reach a point where removal of cap nuts is difficult. If this is a persistent problem, a light application of lubricant can be applied on the first three threads of the stud and the first three threads of the inner cap nut. Care should be taken to keep all lubricant from ball seat of stud hole or ball faces of cap nuts.

In case of a broken, cracked or worn hub face, it should be replaced. A badly worn hub face is always caused by running wheel assemblies in a loose condition. If the wear is not too excessive, the entire hub face can be machined to a flat surface with the studs removed. Otherwise, with a badly out-of-flat or worn condition, the hub should be replaced.

When mounting rear dual wheels, care should be taken to position the tire valve stems 180° apart so that access to both inner and outer tire valves may be obtained (figure 15-2).

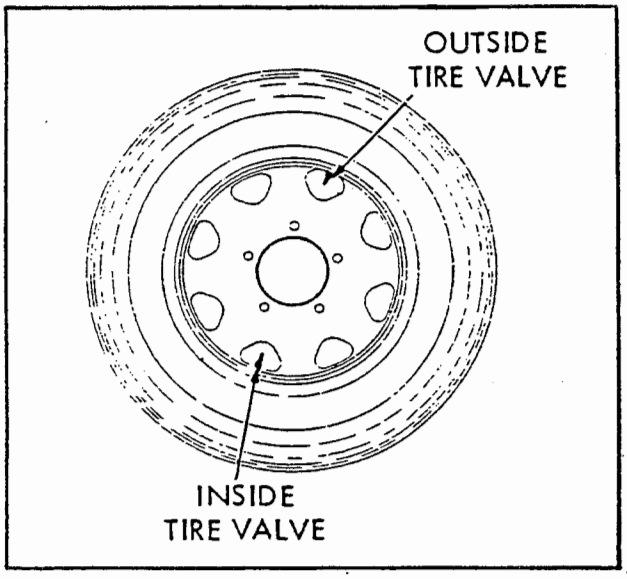


Figure 15-2. Proper Tire Valve Position.

CHANGING WHEELS

Whenever it is necessary to change a wheel when a flat tire occurs, the following procedures should be followed:

FRONT AXLE:

1. Turn front wheels to extreme right or left, depending on which tire is flat, so that the front of the flat tire is turned outward.
2. Run flat tire up on runup block. (Refer to figure 15-3.) Run up block is supplied in the coach tool compartment.
3. Apply parking brakes.
4. Place jack under front jack pad and raise coach.
5. Remove run-up block and proceed to change wheel.
6. Lower jack and remove from under jack pad.

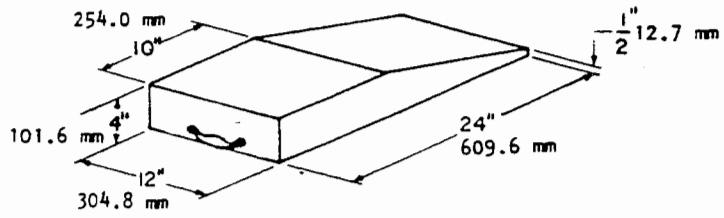


Figure 15-3. Run-up Block.

REAR DRIVE OUTSIDE DUAL:

1. Place wooden run-up block at inside tire.
2. Drive coach onto block to raise outside dual off ground.
3. Fully apply parking brakes.
4. Proceed to change wheel.

REAR DRIVE INSIDE DUAL:

1. Fully apply parking brakes.
2. Position jack under rear jack pad.
3. Jack up axle and proceed to change wheel.

REAR TRAILING WHEEL

1. Release air pressure from bellows by turning the air release valve towards the rear of the coach until air is released from bellows.
2. Position jack under jack pad and jack up flat tire.
3. Change the wheel.

NOTE: If no spare wheel is available for the rear trailing axle, the wheel should be raised and removed from axle. The hold-up link should be installed to hold up the axle. Reduce road speed to a minimum with trailing axle in raised position.

It is important that wheel stud nuts be tightened alternately on opposite sides of wheel. Refer to figure 15-4 for suggested sequence for tightening and follow this recommended procedure:

1. Run the stud nuts in lightly referring to figure 15-4 for sequence so that wheel will position itself concentrically with hub. This is important; otherwise, wheel may be eccentric with hub and will not run straight. In this initial step, run the nuts up only as necessary to correctly position the wheel.
2. Tighten stud nuts progressively as shown in figure 15-4 with an impact wrench.
3. Tighten stud nuts to 450-500 ft. lbs. (610-678 Nm) torque.

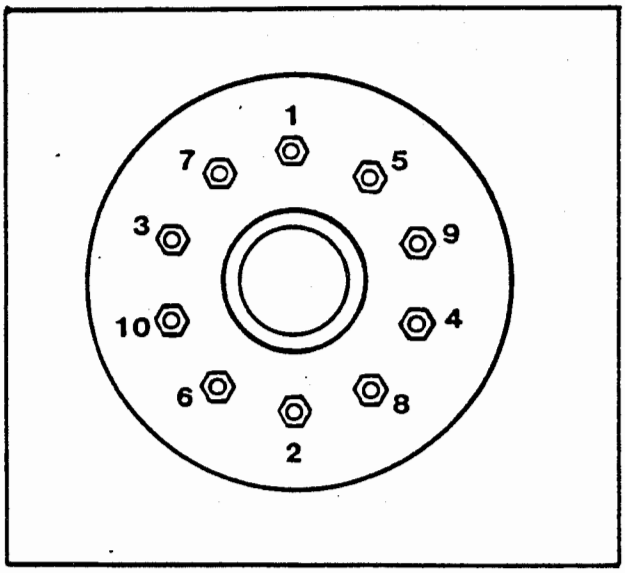


Figure 15-4. Stud Nut Tightening Sequence.

MC-9 MAINTENANCE MANUAL

TIRES

MAINTENANCE

The correct maintenance procedure is essential to safe and economical tire service. Daily, inspect each tire carefully for cuts or foreign matter such as nails, glass, etc. Remove any foreign matter lodged between tires and dual wheels.

Check tire inflation pressure (figure 15-5) with an accurate gauge. Pressure should be checked before starting a run and should be as recommended by tire manufacturer. Always use the same guage to check the pressure to eliminate any differences resulting from gauge error.

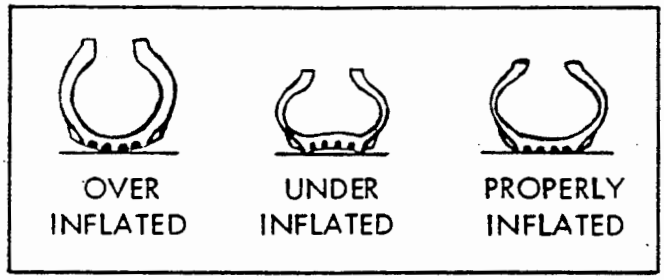


Figure 15-5. Tire Inflation.

If pressure loss is greater than normal, remove and inspect tire to determine cause. Replace any missing valve caps.

NOTE: Tire pressure should be checked with pressure cold.

The valve core is a spring loaded check valve in the stem permitting inflation or deflation of the tire. The valve is provided to seal the air in the tire. When the valve cap is tightened on the stem, the sealing washer inside the cap is pressed tightly against the top of the stem, preventing air leakage.

REPLACEMENT

When tires are changed, especially to the new low profile tires now available, clearances and revolutions per mile may be affected. Before making changes to tires with different specifications, ensure that the replacement tires have adequate clearances and that the revolutions per mile are not seriously affected. Customers who have already changed to replacement tires, especially to low profile tires, should check to ensure that the tires are not rubbing and that the revolutions per mile have not affected the speedometer reading.

INFLATION

Improper inflation is the greatest cause of accelerated tire wear. Tires should be checked frequently for this condition. Unless correct air pressure is consistently maintained, tires will not function as they should; consequently, safe, economical operation of the coach will be affected.

An under-inflated tire runs sluggishly, heats up quickly because of greater flexing, and is subjected to more frequent bruising. Over-inflation does not compensate for over-loading. It does not add strength to the tire; in fact, it actually weakens the tire by reducing its ability to absorb road shock, and may cause a blow-out.

In addition to the effect improperly inflated tires may have on tire life, improperly inflated tires will degrade steering, riding comfort, and safe driving.

All tires on the same axle should always carry the same air pressure. A difference in air pressure between rear tires and front tires may be permissible within certain limitations; however, there should not be a difference in pressures between the right and left tires on the same axle. A 5 psi (34.5 kPa) under-inflation in one front tire not only can cause hard steering, but can create steering hazards which may cause unsafe operation. An under-inflated rear tire can seriously affect braking. Balance tire pressures for ease of steering, comfort in riding, safety in driving, as well as for minimum fuel consumption and maximum tire mileage.

NOTE: Before rotating tires, consult the tire manufacturer. They are the source for directions relating to specific tires.

ROTATION

Radial tires should be rotated only when necessary. If the tires are wearing evenly, there is no need to rotate. If irregular wear becomes apparent, or if the wear rate on the tires is perceptively uneven, the tires should be rotated in such a manner to alleviate the problem. There is no restriction on criss-cross rotation.

Bias-ply tires should be interchanged at regular intervals to obtain maximum life. Change wheels without dismounting tires so direction of rotation will be reversed. The following system of interchanging is recommended: Right front to left rear inside or right rear outside. Left front to right rear inside or left rear outside.

If inside dual tires show more wear than outside dual tires, place front tires on inside when changing. In this case, outside dual tires can be interchanged between right and left side of vehicle.

If outside dual tires show more wear than inside dual tires, place front tires on outside dual tires when changing. At the same time, interchange right and left hand inside dual tires.

New tires should be installed on front wheels where they run coolest. Baggage should always be placed as far to the rear as possible. This puts the load on the rear axle and reduces front tire stress.

SAFETY PRECAUTIONS

WARNING: Exercise care when handling wheels and tires. Careful attention to the following suggestions will prevent injury. Make it a rule to respect the explosive force contained in an inflated tire.

Refer to figure 15-6.

1. Prepare for any tire repair operation in a proper way. In servicing tires be careful not to drop them on the feet, hands or body, or heavily on the floor. Practice proper methods of lifting. When carrying tires or wheels avoid oil and objects on the floor. Keep floor clean and dry.

2. Deflating a tire properly is very important. First reduce pressure as much as possible by pushing the valve core plunger. Keep your eyes away from valve. Remove valve core to ensure complete deflation. Wear approved safety glasses or goggles when using compressed air.

3. Demounting tires from wheels requires special care. Tires on drop center rims are best handled on a wheel holder, or tire changing machine. This will prevent cuts on hands and wrists and will make it unnecessary to use a mallet for seating the tire. Use only standard tire mounting tools and equipment. Use of makeshift tools, screwdrivers, or pliers to force tires on or off rims or wheels is dangerous.

4. Use special care when using tire irons. Grip them firmly and keep them free of oil and grease. They can slip and fly with tremendous force.

5. After removal, a careful inspection of the tire should be made and all necessary repairs performed. A tire spreader is helpful but use care when working around it. Keep spreader arms closed when machine is idle.

6. Inspect wheel parts carefully for rust, damage, or distortion. Never use wheels which are out of shape, rusted, cracked or broken in any way. Never use a ring or other rim parts of different manufacture than the original rims or any different size or type. Tires or rims often require a buffing operation before mounting after repairs are made. Always wear safety glasses or a face shield when buffing tires or rims.

7. Avoid hammering on wheels with steel hammers. Small bits of steel may break off hammer or rim and fly into eyes, face, or body. Use rubber covered, steel-headed hammers whenever possible.

8. Stand away from valve stem as far as possible when inflating tires. Avoid a position where the face or body is immediately over the work being done on any tire in which there is pressure. Use only accurate, tested gauges to insure proper air pressure.

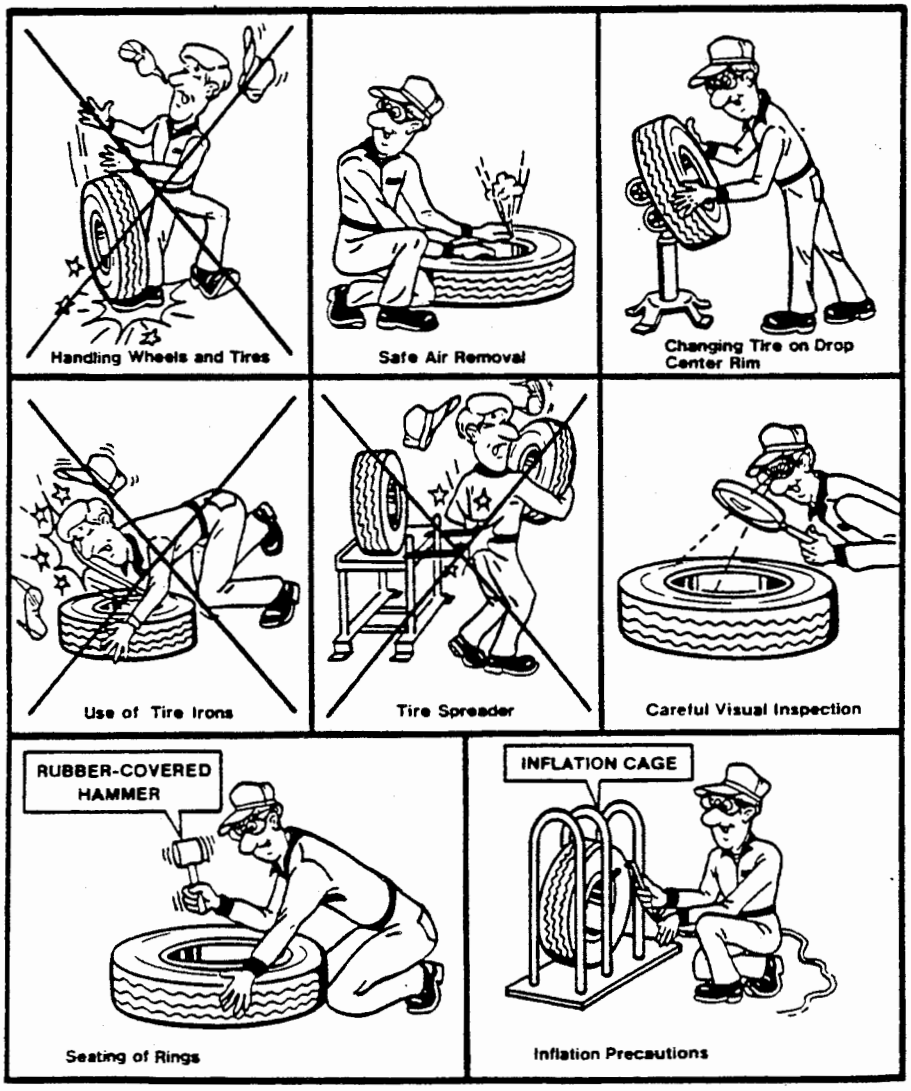


Figure 15-6. Safety Precautions.

MC-9 MAINTENANCE MANUAL

MANUAL DEMOUNTING AND MOUNTING OF TIRES

NOTE: This procedure applies to tires on both demountable rims and disc wheels. Tools required: 2 tubeless tire tools, 1 pair vise-grip pliers, lubricant and brush.

CAUTION: Avoid the use of any lubricant containing water, or any solvent injurious to rubber.

DEMOUNTING

1. Deflate tire.
2. With tire lying flat, loosen both beads by walking on tire with heels close to rim.
3. With wide side of rim down, lubricate top bead.
4. With stops toward rim, insert spoon ends of both tools about 10" (254 mm) apart.
5. Holding bead in well with foot, pull one tool toward center of rim. See figure 15-7.



Figure 15-7. Pulling First Tool Toward Center.

6. Hold tool in position with one foot and pull second tool toward center of rim. Progressively work bead off rim, taking additional bites as necessary (figure 15-8).
7. Stand assembly in vertical position. Lubricate second bead.



Figure 15-8. Second Tool Toward Center.

8. At top of assembly insert straight end of tool between bead and back flange of rim at about a 45° angle. Turn tool so that it is perpendicular to rim. Pry second bead off. See figure 15-9.



Figure 15-9. Prying Off Second Bead.

MOUNTING

1. Be sure correct valve is used and is properly installed in the rim. Inspect rim to insure bead seats are clean and smooth.
2. Place rim on floor with side down and lubricate first bead of tire and upper bead seat of rim (figure 15-10).



Figure 15-10. Applying Lubricant.

3. Push first bead into well of rim and onto rim as far as possible.
4. Using straight end of tool (with stop resting on rim flange), take small bites to work remaining section of first bead on to rim. Refer to figure 15-11.



Figure 15-11. Installing First Bead On Rim.

5. Hold second bead in well by standing on tire and anchor with vise-grip pliers (snub side toward tire).



Figure 15-12. Installing Second Bead.

6. Using spoon end of tire tool with stop toward rim, take small bites until bead slips over flange. If necessary, insert second tire tool and lubricate last 6" (152 mm) of bead before completely mounting (figure 15-12). Inflate tire to recommended pressure. Examine valve assembly occasionally to avoid leaks.

SAFETY PRECAUTION

Use only rims free from damage, rust or pitting.

FRONT AND TRAILING WHEELS

Front wheel and trailing wheel hubs use oil lubrication which eliminates periodic repacking of the hubs. A sight glass is provided for convenient check of oil level which should be checked daily; if not visible in the sight gauge level mark, sufficient SAE 30 engine oil should be added through the composition snap plug at the center of the hub cap to bring level to the correct point.

BEARING ADJUSTMENT

To adjust the wheel bearings:

1. Remove capscrews, lockwashers, hub cap, and gasket.
2. Flatten lock nut retainer and remove lock nut, and lock nut ring.
3. Before bearing adjustment is made, brakes must be released and must not drag.
4. Check bearing play by jacking up the wheels one at a time and observing bearing play using a long bar under the tire.
5. Observe movement of brake drum in relation to brake spider. If bearings are adjusted properly, movement of the drum will be just perceptible and the wheel will turn freely.
6. Tighten adjusting nut to 150 lb-ft (203 Nm) torque while at the same time rotating the wheel in both directions to make sure all surfaces are in proper contact.
7. Back off adjusting nut about ¼ turn to make sure the wheel turns freely.
8. Replace lock ring with valve pin in adjusting nut inserted in the hole of the ring.
9. Install nut lock, lock ring, lock nut and tighten to 100-150 lb. ft. (136-203 Nm) torque.
10. Recheck bearing adjustment and repeat the above steps if necessary.
11. Bend lips of nut lock over flats of lock nut.
12. Replace gasket and hub cap using new gasket and lockwashers.

DISASSEMBLY AND INSPECTION

1. If bearings are to be removed, jack up vehicle and remove wheel.
2. Remove brake drum-to-hub retaining screws and remove brake drum. See figure 15-13.
3. Remove hub cap and gasket.
4. Remove lock nut, nut lock, lock ring and bearing adjusting nut.
5. Pull hub assembly off spindle, being careful not to let the bearing fall out of hub. The oil seal and bearings can now be removed from the hub.

All parts should be thoroughly cleaned. Bearing cone and roller assemblies can be cleaned in a suitable cleaning solvent using a stiff brush to remove old lubricant.

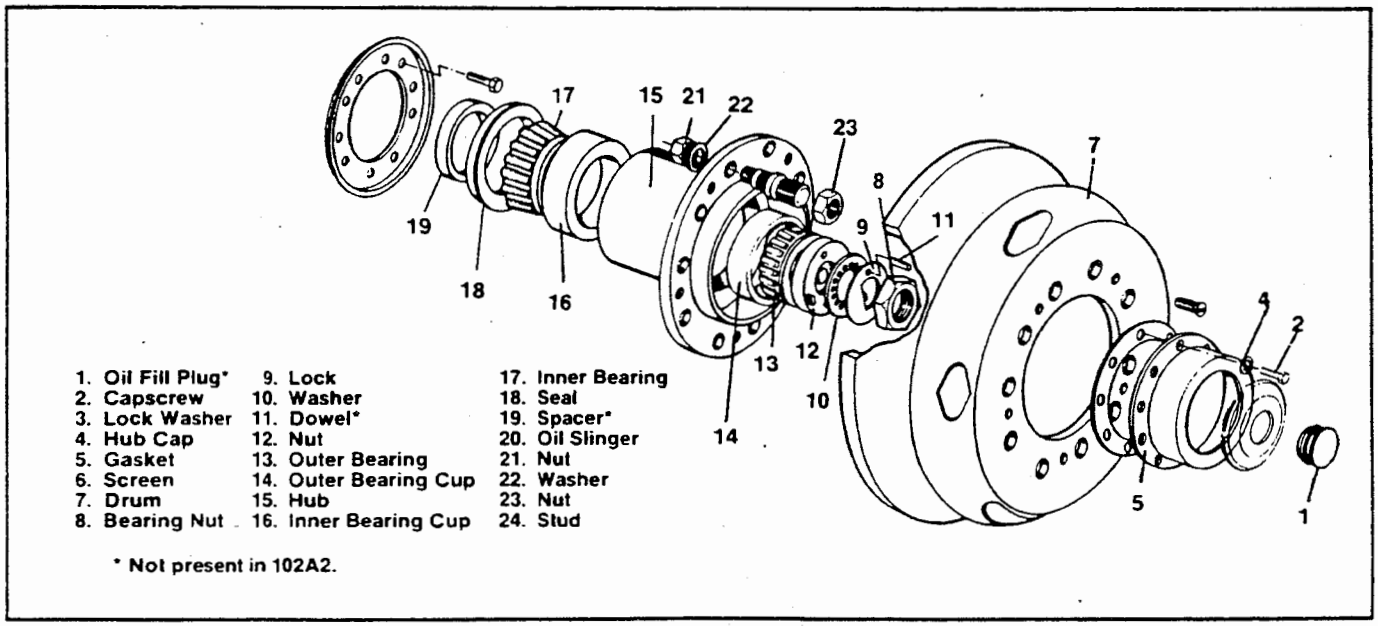


Figure 15-13. Front and Trailing Hub and Drum.

If excessive wear, deterioration, cracking, scoring or pitting are present on the bearing cups, rollers or cones, the bearings should be replaced. Seals should be inspected for wear, deterioration, distortion, or damage at the sealing surfaces. Defective seal assemblies should be replaced.

Installation is the reverse of disassembly. Refer to Oil Seals, Front Wheels and Trailing Wheels, for oil seal installation. Bearings must be adjusted as explained in previous procedure.

DRIVE WHEELS

Drive wheels use a single oil-seal assembly and are lubricated from the supply of oil in the differential housing. Bearings are tapered roller, adjustable for wear.

The hubs require no periodic checking of lubricant level, provided correct level is maintained in the differential housing.

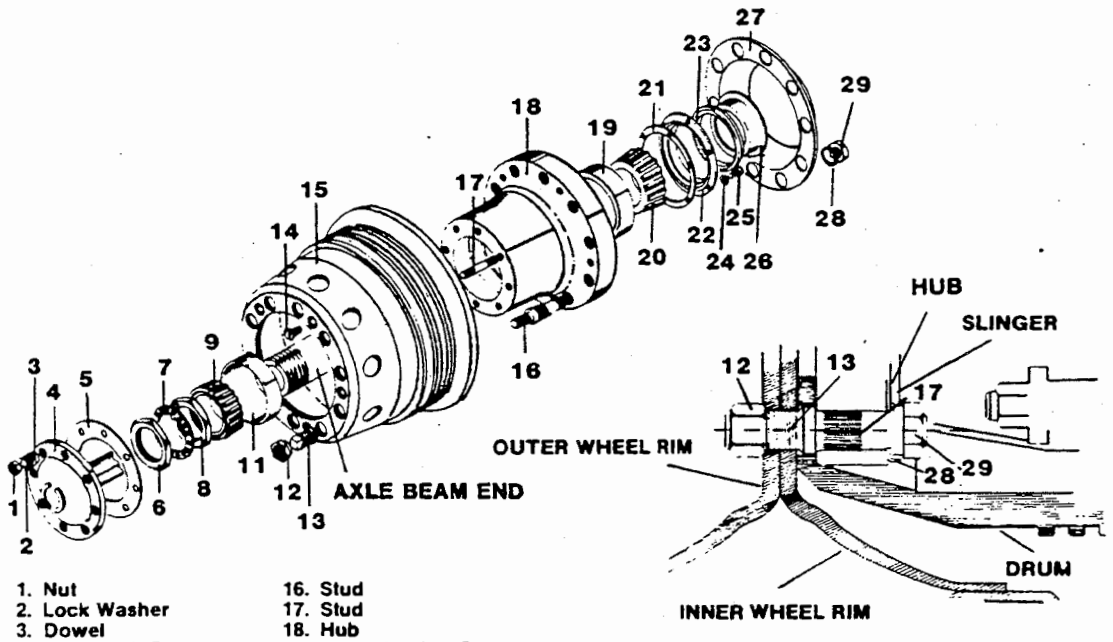
BEARING ADJUSTMENT

To adjust the drive wheel bearings, proceed as follows:

1. Jack up the rear of the coach after blocking the front wheels to prevent rolling.
2. Remove the plug from the bottom of the axle housing and drain the lubricant.
3. Remove the axle shaft drive stud nuts and lock washers. See figure 15-14.
4. Using a heavy steel hammer or drift, sharply rap the axle shaft flange in the center to free the tapered dowels.
5. Remove the dowels.

CAUTION: Do not pry the axle shaft free. To do so will damage the hub and oil seals.

6. Remove the axle shaft.
7. Remove and discard the axle shaft gasket.
8. Remove the outer bearing lock nut and washer.
9. While rotating the wheel, tighten the adjusting nut until the wheel binds. This assures proper contact of all bearing contact surfaces.
10. Back off the adjusting nut approximately ⅛ turn and check that the wheel turns freely.
11. Replace the washer, positioning locking tab in groove of axle beam.
12. Install lock nut, tighten to 100-125 ft. lbs. (136-170 Nm) torque.
13. Rotate wheel to check bearing adjustment. Wheel must rotate freely without any end play.
14. Install axle shaft and new gasket. Take care to properly mate shaft splines in drive gear of differential.
15. Insert the tapered dowels into the shaft flange and hub.
16. Install the stud nuts and lock washers. Tighten to 200-250 ft. lbs. (271-339 Nm) torque.
17. Clean differential drain plug of any steel particles captured by the plug's magnetism and install in differential case.
18. Remove fill plus and add proper quantity of oil as specified in Sections 2 and 10 of this manual.



1. Nut
2. Lock Washer
3. Dowel
4. Axle Shaft Flange
5. Axle Shaft Gasket
6. Bearing Nut
7. Washer
8. Adjusting Nut
9. Outer Bearing Cone
10. Outer Bearing Cup
11. Screw
12. Nut
13. Nut
14. Retaining Screw
15. Drum
16. Stud
17. Stud
18. Hub
19. Inner Bearing Cup
20. Inner Bearing Cone
21. Gasket
22. Seal Retainer
23. Seal
24. Washer
25. Retainer Screw
26. Oil Seal Wiper
27. Oil Slinger
28. Washer
29. Nut

Figure 15-14. Drive Axle Hub and Drum.

DISASSEMBLY AND INSPECTION

First block the front wheels to prevent the coach from rolling, jack up the rear and remove the wheel nuts, tires and rims. Then perform steps 2 thru 8 of the previous procedure (Bearing Adjustment). Follow this procedure for disassembly and repair:

1. Remove the drum-to-hub retaining screws.
2. Remove the brake drum from the hub.
3. Remove the bearing nut washer and adjusting nut.
4. Remove the hub, taking care that the outer bearing cone does not fall out of the hub.
5. Remove the outer bearing cone.
6. Remove the nut and washer mounting the oil slinger to the hub. Remove the slinger.
7. Remove the seal retainer screws, seal wiper, washer, the seals, seal retainer and gasket. Discard the gasket.
8. Remove the inner bearing cone.
9. Using a hammer and brass driver, remove the inner and outer bearing cups.
10. Clean all parts thoroughly with cleaning solvent. Dry with compressed air. Use a stiff brush to remove hard, caked-on lubricant.
11. Inspect bearing cups, cones including rollers and hub for pitting, scoring, cracks, deterioration or wear. Replace as necessary.
12. Inspect seals for distortion, cracks, deterioration or damage. Replace as necessary. Refer to Oil Seal Installation, below.
13. Installation procedure is reverse of disassembly.
14. Perform adjustment procedure as specified.

OIL SEAL INSTALLATION

FRONT HUBS AND TRAILING WHEEL HUBS

Tool 20-103 should be used for the installation of oil seals into the seal bore of the hub. Use of this tool assures correct placement of the seal to prevent leakage of lubricant.

FRONT HUBS AND TRAILING WHEEL HUBS

Proceed as follows to install the oil seal in the front hubs and trailing wheel hubs (inner bearing cup must be in place in hub):

1. Remove any burrs or nicks from spindle shoulder. Use emery cloth or stone.
2. Apply liberal coat of Boretite sealant (Chicago-Rawhide) or equivalent to spindle shoulder O.D.
3. Bolt the centering plate of tool 20-103 to the hub. Bolts need only be finger-tight.
4. Turn wheel over and remove any burrs or nicks from the bore of the hub.
5. Lightly coat bore of hub with Boretite or equivalent.
6. Insert rod (cotter pin end) of tool 20-103 in hole of centering plate.
7. Apply lubricant to inner bearing cone and insert into cup in hub.
8. Place tool 20-103 squarely on edge of seal bore.
9. Slip the seal adapter over the tool rod. Rest it on the seal so that the lip of the adapter fits over the outside of the seal (figure 15-15).
10. Insert centering plug in bore of inner bearing cone (figure 15-16).

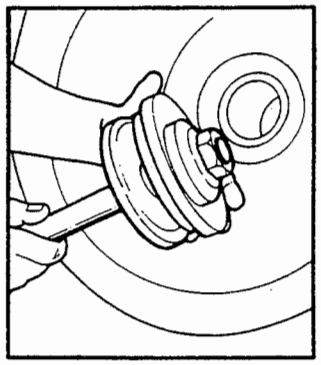


Figure 15-15. Seal and Adapter on Tool Rod.

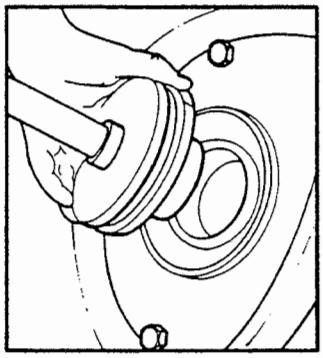


Figure 15-16. Installing Tool With Seal in Hub.

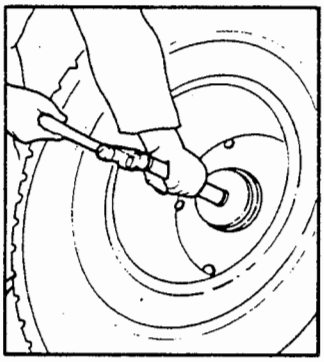


Figure 15-17. Driving Seal Into Bore.

11. Using either a 3-5 lb. (1.4-2.3 kg) hammer or slide-hammer, drive the seal into the bore until it bottoms out. See figure 15-17.
12. Remove tool 20-130 and centering plate. Wheel is now ready for installation on the axle.

CAUTION: Do not damage seal when installing wheel over axle spindle.

Refer to Bearing Adjustment, above, to seat and adjust the wheel bearings. Add the correct quantity of SAE 30 engine oil to the hub for proper lubrication.

DRIVE WHEEL HUBS

Follow this procedure to install the oil seal in the drive wheel hub (inner bearing cup and cone must be in place in hub):

1. Remove any nicks or burrs from the axle housing seal shoulder.
2. Apply a liberal coat of Boretite sealant (Chicago-Rawhide) or equivalent to shoulder OD and face.
3. Apply light coating of Boretite sealant or equivalent to retainer face.
4. Install retainer and new gasket in hub.
5. Bolt the hub bar to the hub. Use two flange nuts and install finger-tight.
6. Turn the wheel over.
7. Coat the bore of the seal retainer with Boretite sealant or equivalent.
8. Insert the assembly rod (cotter pin end) in the center hole of the hub bar.
9. Slip seal adapter over the rod and locate it on the seal so that the lip of the adapter fits over the outside of the seal. Refer to figure 5-15.
10. Position the tool squarely on the edge of the seal bore (figure 15-16).
11. Using either a 3-5 lb. (1.4-2.3 Kg) hammer or slide-hammer, drive the seal into the bore until it bottoms (figure 15-17).
12. Remove the tool hardware. The wheel is now ready for installation on the coach.

Refer to Bearing Adjustment. above. to seat and adjust the wheel bearings. Add the correct quantity of SAE 140 (0°F & above) or SAE 90 (below 0°F) differential oil to the differential to provide proper lubrication for the hub.

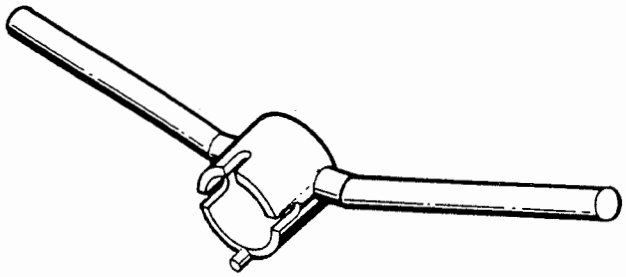
MC-9 MAINTENANCE MANUAL

SPECIFICATIONS

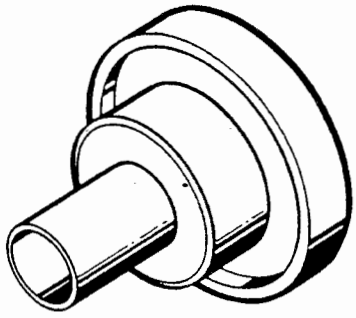
Wheel Size	22.50 x 8.25" (571.5 x 209.5 mm)
Tire Size - Tubeless ("G" Rated)	12.00 x 22.50" (304.8 x 571.5 mm)
	12.50 x 22.50" (317.5 x 571.5 mm)
Tire Size - Tubeless Radial	12.75R x 22.50" (323.9 x 571.5 mm)
Wheel Stud Nut Torque	450-500 ft. lbs. (610.2 x 678.0 Nm)

SERVICE TOOLS

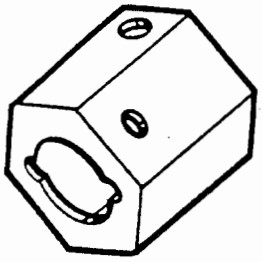
MANY OF THE TOOLS LISTED IN THIS SECTION ARE SPECIALLY DESIGNED TO MEET THE NEEDS OF VARIOUS SERVICE OPERATIONS. THEY ARE AVAILABLE FOR PURCHASE THROUGH MOTOR COACH INDUSTRIES, SERVICE PARTS DIVISION AND UNIVERSAL COACH PARTS OR WHERE PRACTICAL, MAY BE MANUFACTURED BY THE OPERATOR. IN THESE CASES, DRAWINGS ARE AVAILABLE UPON REQUEST.



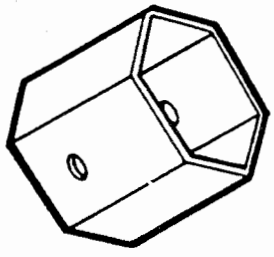
20-56 Wrench Assy. - Front & Trailing Axle Bearing Nut



20-103 Tool - Oil Seal Installation



20-167 Wrench - Front & Tag Axle Nut



20-168 Wrench - Rear Main Axle Bearing & Lock Nut

Date 1-1-89

MC-9 MAINTENANCE MANUAL

SECTION 16
HEATING AND AIR CONDITIONING

SUBJECT	PAGE
Air Conditioning Compressor	16-20
Air Conditioning Compressor Belt Tension	16- 9
Air Conditioning Condenser	16-11
Air Conditioning Cycle	16- 6
Air Conditioning Evaporator	16-11
Air Conditioning Evaporator Fans & Motor	16-12
Air Conditioning Filter	16-12
Air Conditioning & Heater Switch	16- 5
Air Conditioning Receiver Tank	16-12
Air Conditioning System	16- 5
Air Conditioning System Maintenance	16- 7
Air Conditioning System Test Equipment	16- 7
Air Conditioning System Troubleshooting	16-19
Blower Motors	16- 5
Compressor Clutch	16-30
Compressor Disassembly	16-23
Compressor Lubrication System	16-21
Compressor Reassembly	16-27
Compressor Removal	16-22
Compressor Replacement & Installation	16-23
Compressor Wear Limits	16-39
Driver's Heater Water Valve	16- 4
Expansion Valve	16-13
Expansion Valve Troubleshooting	16-17
Fast Idle	16- 7
Filter Dryer	16-12
Fresh Air Ventilation	16- 2
Heating System	16- 1
High & Low Switch Tests & Unloader Check	16-22
Leak Testing Lines & Fittings	16-18
Liquid Line Solenoid Valves	16-13
Main Heater Water Valve (Air Operated)	16- 3
Manual Switch Controls	16- 7
Purging A/C System at the Receiver Tank	16-12
Service Tools	16-40
Specifications	16-38
Suction & Discharge Service Valves	16-21

MC-9 MAINTENANCE MANUAL

HEATING AND AIR CONDITIONING

HEATING SYSTEM

The coach is provided with a hot water forced-air heating system which uses the engine cooling medium for heating the interior of the vehicle and windshield defrosting. Two heating radiator cores are provided, one for the main interior heating system and one for the driver's heater and defroster.

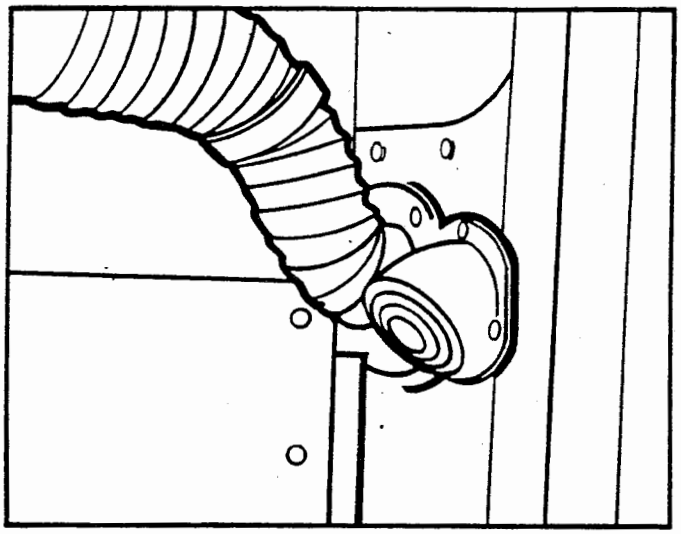
Heating in the stepwell area is provided by the introduction of heated air from the main right hand passenger heating duct into the stepwell. The heat enters the stepwell through louvers at the rear of the stepwell.

A complete air conditioning system is installed as standard equipment. The same duct system is used for both air conditioning and heating.

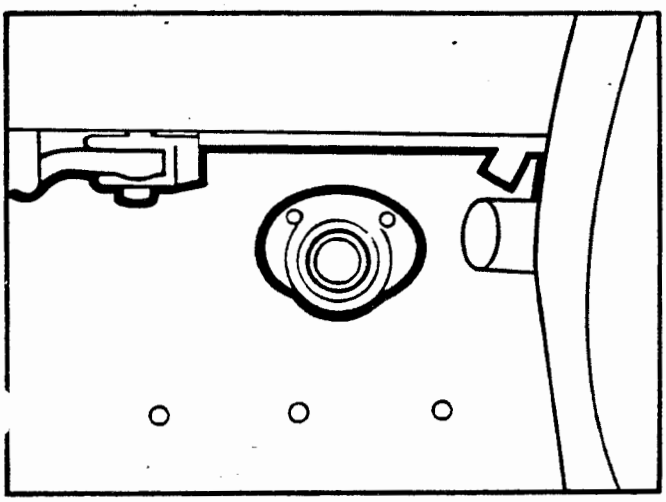
An optional auxiliary air conditioning evaporator and blower unit is mounted at the extreme rear of the left hand side parcel rack. This unit operates in conjunction with the main coach air conditioning system and is controlled by its own coach temperature sensing unit. This auxiliary air conditioner can be used with either Freon 12 or with Freon 500. The purpose of this unit is to provide additional cooling at the rear of the passenger compartment.

Flow of hot water to the main heater core is controlled by an electric water valve. A manually-operated water valve controls the flow to the driver's heater core. In the engine compartment, manually-operated shut-off valves are provided to isolate the heating system in the event of system failure or when the cooling system is to be drained.

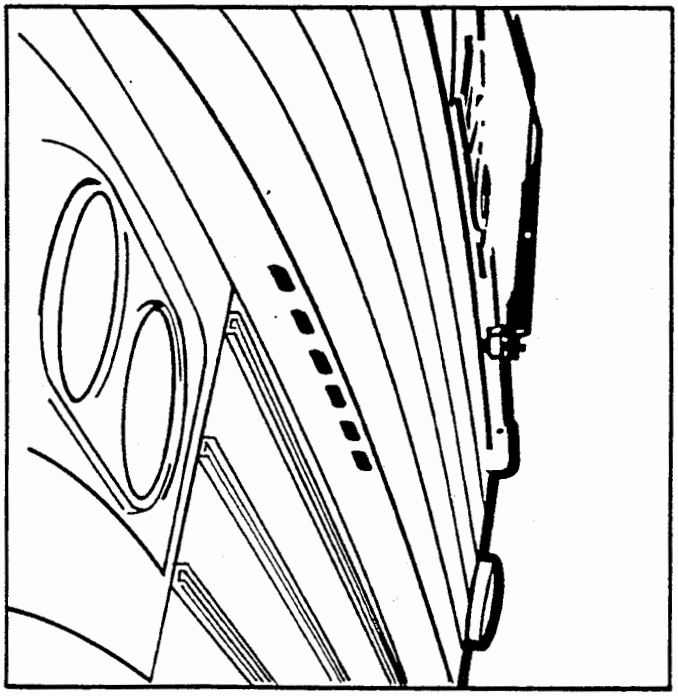
A temperature sensing unit is located in the front L.H. baggage compartment at the center control duct and through relays, controls the main heater water valve within limits selected by means of the heat control dial on the driver's switch panel.



Driver's heater or air conditioning Gasper located to the right of the driver under the dash.

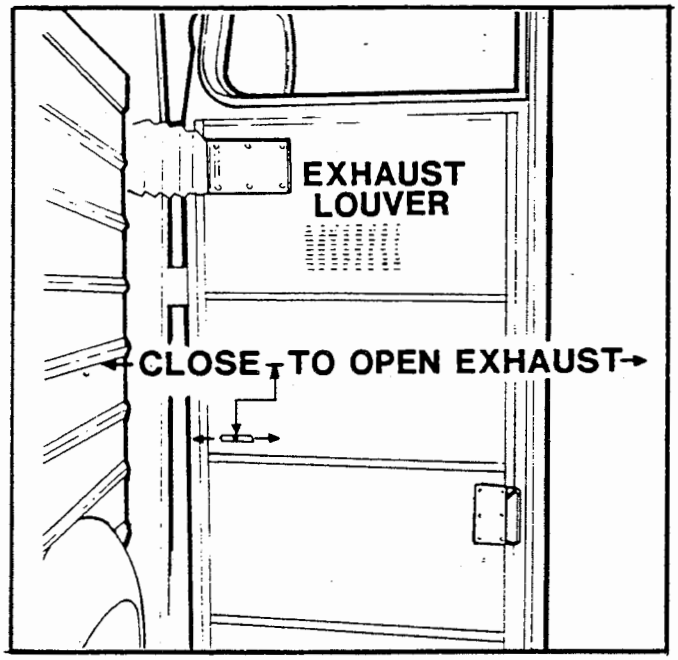


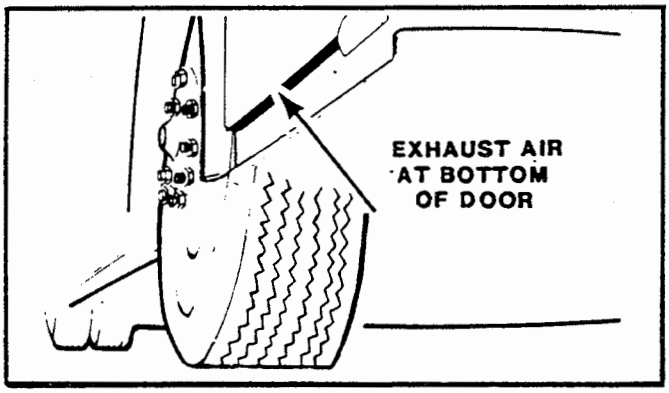
Driver's fresh air located to the left of the driver under the dash.



Fresh air intake above Tire Compartment

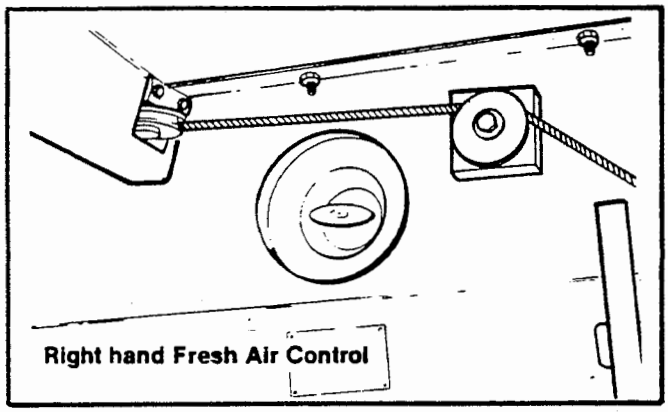
MC-9 MAINTENANCE MANUAL

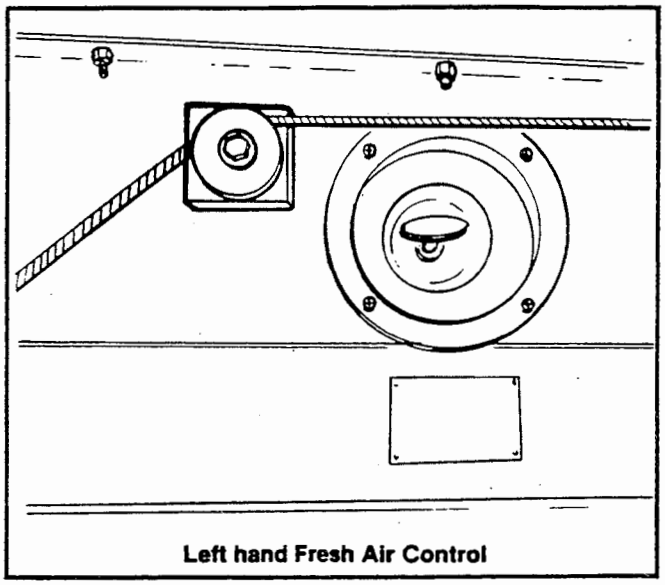




FRESH AIR VENTILATION

Some MC-9 coaches are equipped with controls to regulate the percentage of outside air being drawn into the coach and mixed with recirculated air. The controls should normally be in the closed position. Even in this position approximately 20% of the conditioned air is fresh outside air. This provides a healthy, fresh atmosphere in the coach.





At intervals depending entirely on service conditions, the A/C air filter should be removed and washed. To reach the filter, open the battery compartment door, unlatch locks and pull out. The filter is provided with a grab handle for removal.

When the cooling system is drained and flushed (Refer to Section 6, Cooling), the heating water system should be similarly serviced.

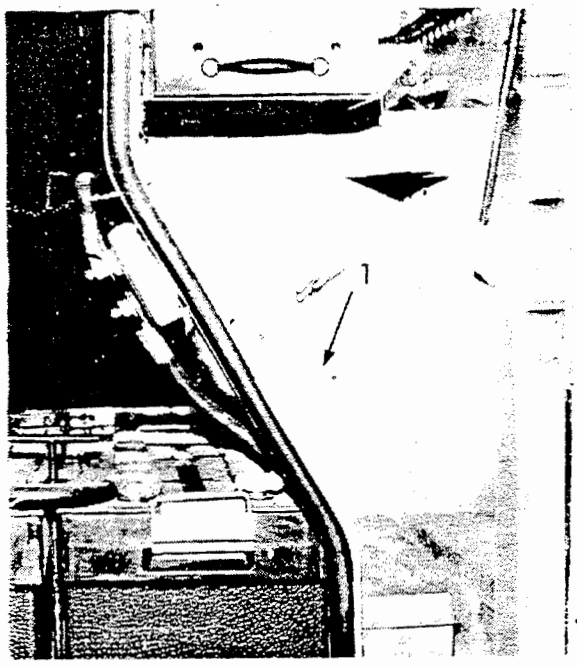


Figure 16-1. A/C Filter

DRAINING AND REFILLING

Refer to Section 6 (Cooling) for instructions on draining and refilling the engine cooling and coach heating system.

If the heating system is to be drained without draining the engine cooling system, close gate valves in engine compartment and drain radiator cores. A manual vent plug is provided in the top of the main heater core and at the top of the driver's heater core for bleeding air while refilling. The vent plugs allow air to enter during draining.

OPERATION

Controls for coach heating system are located at the driver's switch panel. The temperature control selects the temperature range desired and the system automatically maintains the pre-set limits. Blower motors for coach heating, driver's heater and defroster are controlled by switches on the driver's switch panel.

MAIN HEATER WATER VALVE
(ELECTRICALLY ACTUATED)

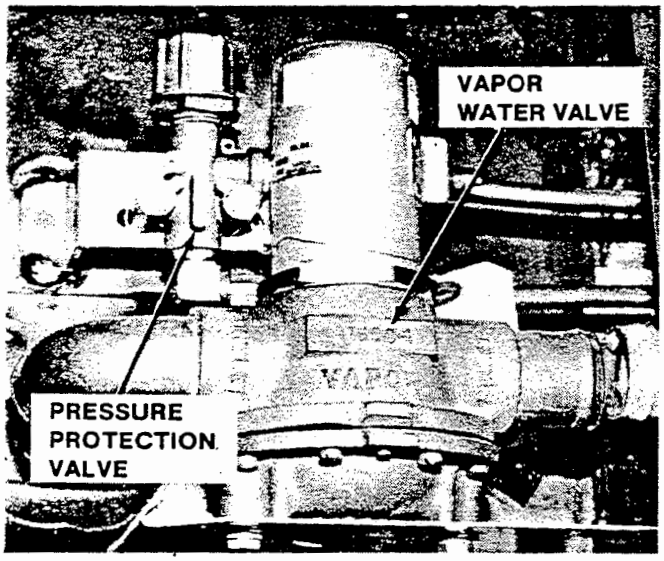


Figure 16-2A. Electrically Actuated Main Heater Water Valve Used Prior To Unit 39263.

Prior to unit 41089, the flow of hot water to the main heater core is controlled by an electric water valve mounted in the right front baggage compartment.

Valves from two different manufacturers are present on the coaches built prior to unit 41089. One make was used prior to unit 39263 and another was used from unit 39263 through unit 41088. These two valves are interchangeable as complete assemblies. Refer to TMC/MCI Service Bulletin No. 2224 for information on replacing the earlier valve with the later vaive.

NOTE: The following information applies specifically to the earlier valve but is generally applicable to the later one.

The valve is designed so that the pilot valve within the assembly opens and closes a port which directs pressure to either the top or bottom of the valve diaphragm, thus opening or closing the valve.

A delay action is built into the water valve through the means of an orifice in the valve body and a modulating cup on the diaphragm assembly. When the coach is operating with no current to the water valve solenoid, inlet water pressure is directed to the upper side of the diaphragm, thus forcing it open.

The pilot valve is normally open, relieving any build-up of pressure under the diaphragm. When the solenoid is energized the pilot valve closes, water pressure builds up through the orifice to the underside of the diaphragm and keeps the valve in closed position.

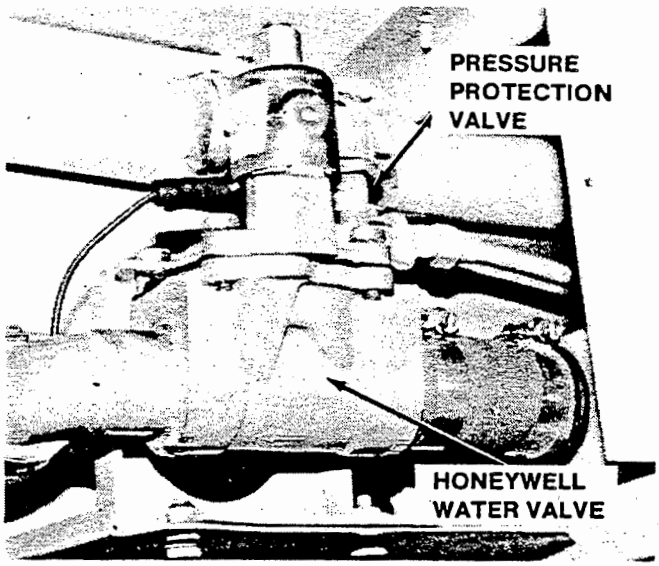


Figure 16-2B. Electrically Actuated Main Heater Water Valve Used On Units 39263 Through 41088.

MAINTENANCE

The main heater water valve requires a minimum amount of maintenance. The valve should be free of any sediment or dirt which might interfere with its operation. The diaphragm (8) (figure 16-2C) should be replaced every year before the heating season begins. No other maintenance is needed unless a malfunction occurs.

OVERHAUL

In the event of a malfunction, remove the water valve from the system.

CAUTION: Do not allow any liquid to reach the solenoid coil. After removing the valve from the system, carefully drain the remaining liquid from the inlet and outlet openings.

DISASSEMBLY

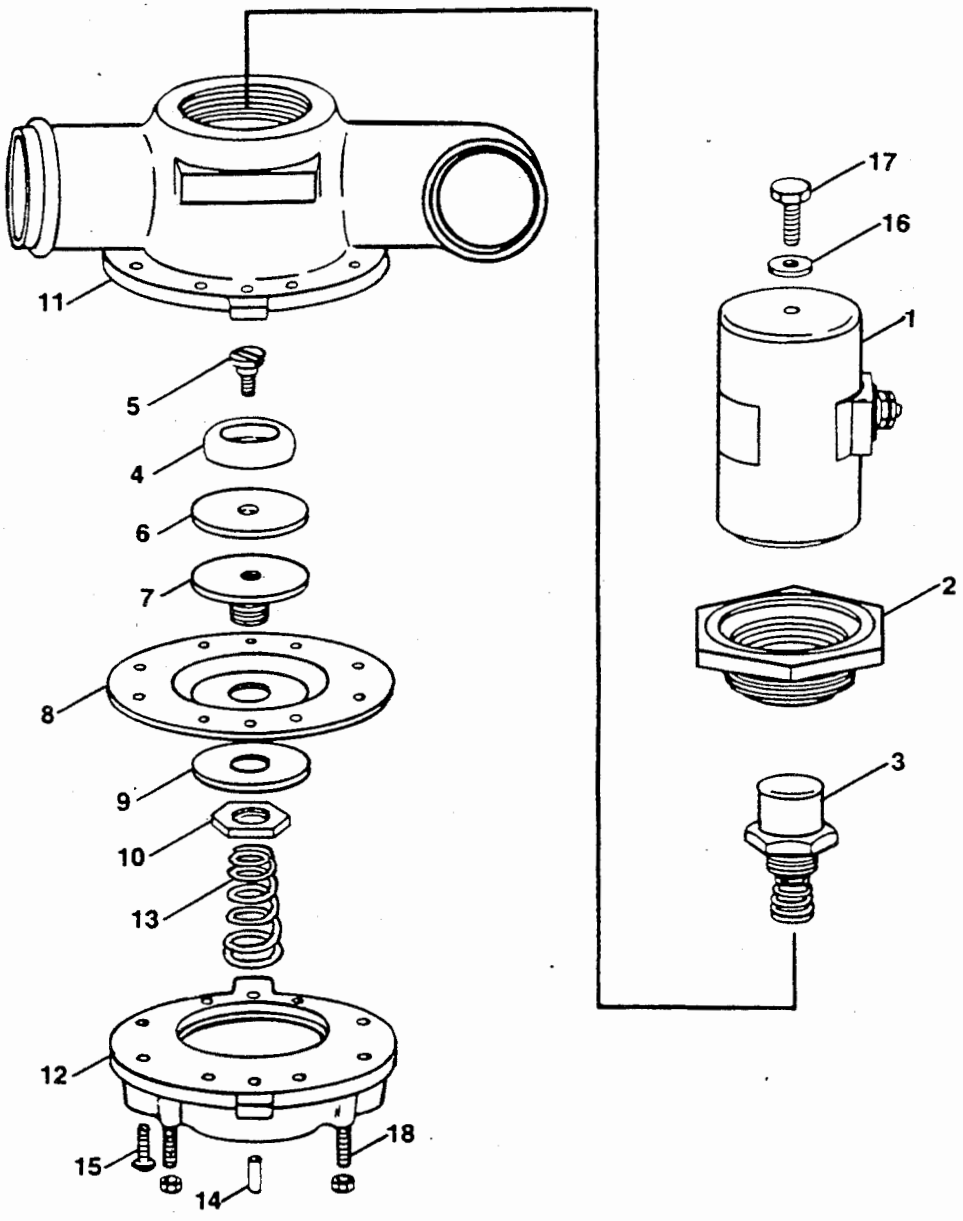
Refer to figure 16-2C.

Remove the terminal nuts, lockwashers, and washers from the valve.

Remove the screw (17) and lockwasher (16) from the coil and container assembly (1).

Remove the valve seat assembly (3) from the coil and container assembly (1) by turning it counterclockwise with a wrench.

MC-9 MAINTENANCE MANUAL



1. Coil & Container Assy.
2. Ring Assy.
3. Valve Seat Assy.
4. Modulator Flow
5. Screw
6. Disc.
7. Retainer
8. Diaphragm
9. Washer
10. Lock Nut
11. Body Assy.
12. Bottom Plate

Figure 16-2C. Main Heater Water Valve Disassembled.

NOTE: The valve should be held secure in a padded vise for disassembly.

The valve seat assembly (3) must be replaced in its entirety if it is damaged or worn.

Remove the eight No. 10-24 fillister head machine screws (15) used to secure the lower valve body (12) to the upper valve body (11). Carefully separate the two portions by using a screwdriver at the two pry-lugs on either side of the valve. The dowel pin (14) will remain in the upper valve body.

The diaphragm valve disc assembly is now removed and the diaphragm replaced. This is done by removing the locknut (10) and the diaphragm washer (9). If difficulty is experienced in removing the locknut, carefully hold the assembly in a vise between two strips of soft wood.

CAUTION: Do not tighten vise so as to damage or bend the disc assembly.

The locknut (10) should be torqued to 25-30 inch pounds (2.8-3.3 Nm) and the valve disc screw (15) is torqued to 12-15 inch pounds (1.3-1.6 Nm).

CLEANING AND INSPECTION

Before reassembling the valve, make sure that all parts are clean and in good condition. Thoroughly clean the serrations in the upper and lower valve bodies.

If the valve seat assembly is defective or leaks more than six drops per minute at 10 psi (69 kPa) when the coil is energized, it should be replaced.

REASSEMBLY

Position the diaphragm disc assembly on the upper valve body (11) so that the holes in the diaphragm align with the dowel pin (14) as well as with the pilot-channel hole and the valve body mounting holes. Set the conical spring (13) on the locknut (10). Carefully place the lower valve body (12) on the diaphragm disc assembly, engaging the dowel pin (14) with the hole opposite. Secure the eight No. 10-24 fillister head machine screws (15). Tighten the screws evenly around the valve body to 15 in. lbs. (1.6 Nm). Insert the valve seat assembly into the upper valve body (11) and tighten.

Screw the flux ring assembly (2) into the valve body.

Seat the cover assembly firmly on the flux ring assembly and tighten.

TESTING VALVE AFTER SERVICING

After servicing, the valve should be tested using water at approximately 170°F ± 10° (77°C ± 6°) and DC voltage at 24 VDC.

Apply water at 25 psi (172 kPa) to valve inlet and outlet; check for external leakage.

Reduce pressure to 10 psi (69 kPa) and open valve outlet. Check operation of valve by cycling valve several times.

Check internal leakage (through seat and needle valve) with 10 psi (69 kPa) at valve inlet and solenoid energized. Maximum allowable leakage is six drops per minute through the needle valve and zero leakage through the disc seat.

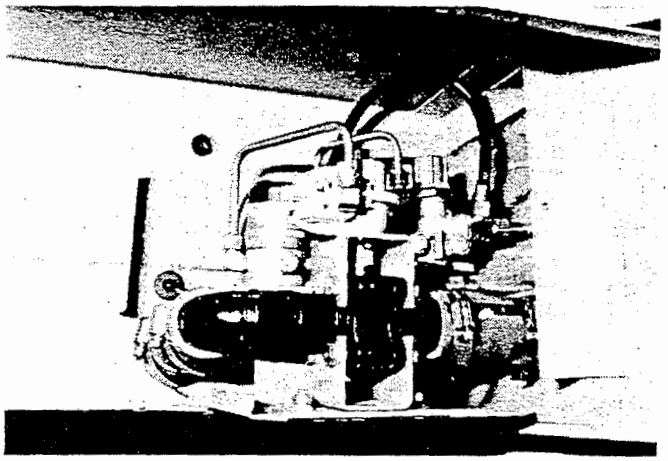


Figure 16-3. Air Operated Water Valve Installed (Effective With Unit 41089).

An air operated type of main heater water valve is used effective with unit 41089 (figure 16-3).

The bonnet of the valve contains a vane which is connected to a ball in the valve body. The valve is double acting; air is applied to both open and close the valve. The side of the vane to which air pressure is applied is controlled by a separate solenoid valve mounted on the same bracket as the water valve. The solenoid is activated by signals from the coach temperature control system which is described later in this section.

The air operated valve does not require any particular servicing; however, if for any reason the valve is disassembled, care must be taken in its reassembly so that the ball is oriented in the correct position in the valve body with respect to the direction of air flow against the vane. If this is not done, any signal to the solenoid valve from the temperature control system will result in the ball in the valve moving in the opposite direction to what is desired, with a consequent effect on the water flow.

DRIVER'S HEATER WATER VALVE

DESCRIPTION

The driver's heater control valve is manually operated. It is located at the left-hand side of driver in heater duct panel at floor.

Note: Before removal of shut-off valve it is necessary to close valve in engine compartment. This prevents extensive water drainage from coolant system.

REMOVAL

1. Remove the valve control handle from the inside of the coach.
2. Open the exterior service door under the driver's window.
3. Disconnect the heater hose clamps at front and rear of valve assembly.

Slide hoses away from valve assembly. Remove the two hex nuts and screws which mount valve assembly Remove complete valve assembly.

MC-9 MAINTENANCE MANUAL

DISASSEMBLY

1. Remove cotter pin from crank pin and slide yoke off.
2. Remove two hex nuts holding valve to mounting bracket.

REASSEMBLY

1. Mount new valve to bracket fastening with same screws and hex nuts removed during disassembly.
2. Install yoke to valve crank pin using new cotter pin. Valve assembly, complete with mounting bracket, is now ready for installation.
3. Mount the valve assembly with two hex nuts and screws.
4. Slide front and rear hoses over inlet and outlet of valve assembly and fasten clamps.
5. Install the valve control handle from the inside of the coach.

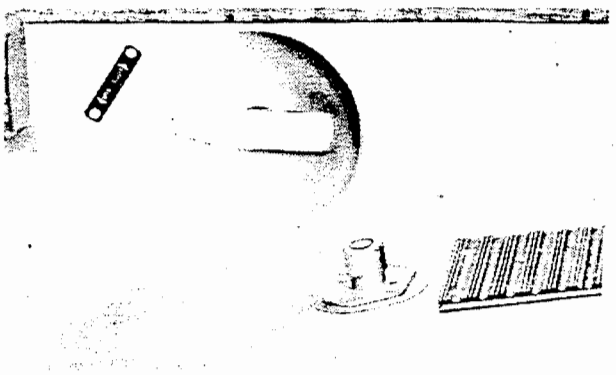
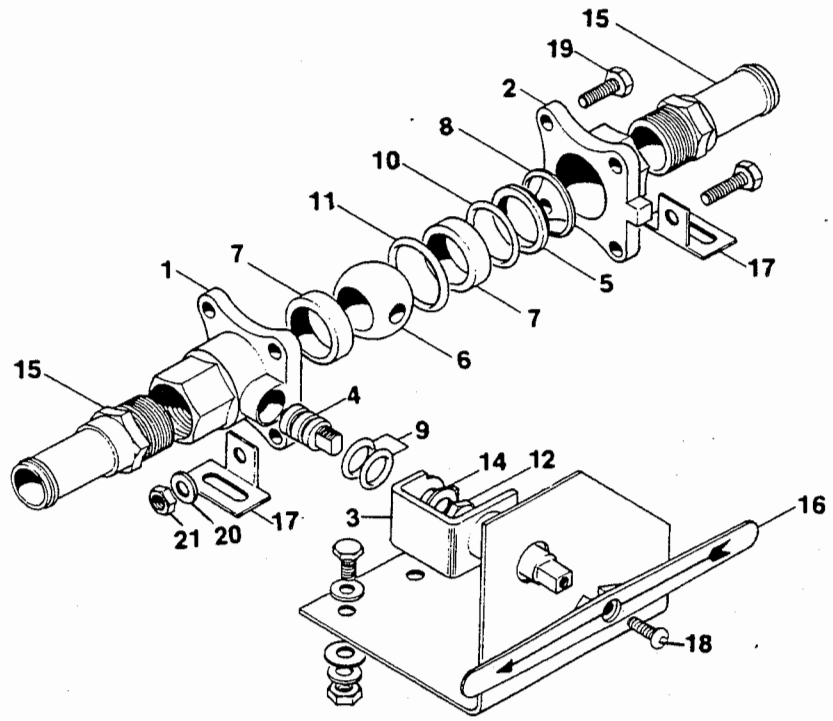


Figure 16-4. Driver's Heater Shut-of Valve.



1. BODY
2. CAP
3. STEM S/A
4. STEM
5. DISC
6. BALL
7. SEAT
8. SPRING
9. 'O' RING-STEM SEAL
10. 'O' RING-SEAT SEAL
11. 'O' RING-JOINT SEAL
12. JAM NUT
13. HEX. MACH. SCREW-¼-20 x ⅝
14. INTERNAL TOOTH LOCKWASHER
15. EXTENSION S/A
16. HANDLE
17. VALVE MTG. ANGLE
18. SCREW-#10-24
19. SCREW-¼-20 x 1
20. LOCKWASHER-¼"
21. HEX. HD. NUT-¼"

Figure 16-4A. Driver's Heater Shut-of Valve Disassembled.

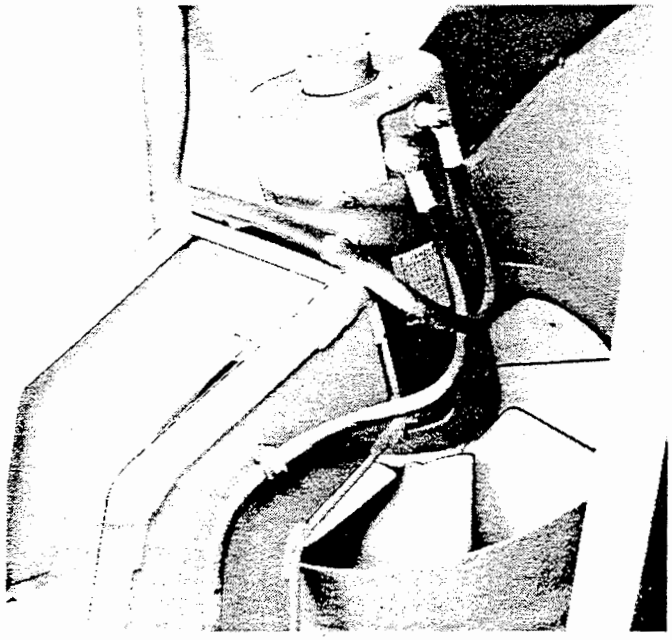


Figure 16-5: Axial Fan and Motor in Condenser Compt.

BLOWER MOTORS

All blower motors are 24 volt units of conventional design. Defective motors may be repaired according to standard procedures.

CAUTION: Do not use emery cloth or sandpaper for seating brushes or cleaning commutators. Motor brushes should be checked at regular intervals. New brushes should be seated using a bedding stone.

The blower motor for the central heat compartment is a 1½ h.p. unit (1.1 KW). The motor for the axial fan is a 2 h.p. unit (1.4 KW).

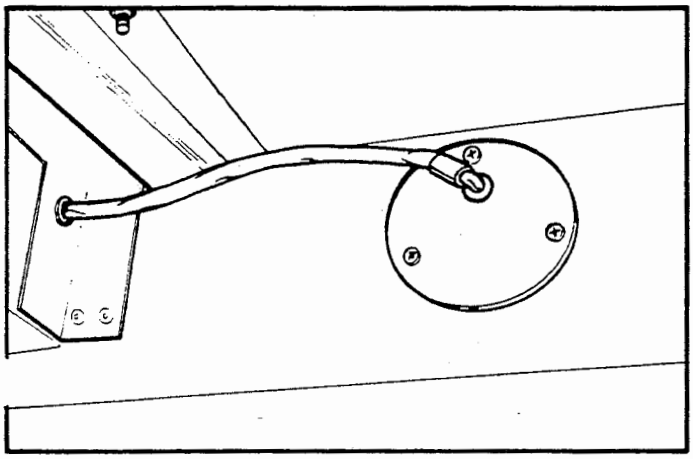


Figure 16-6: Sensing Unit installed at Center Control Duct

TEMPERATURE

The temperature control is a rheostat unit which increases the resistance in the thermostat sensing element, causing cycling at higher or lower temperatures (68°-78°F; 20°-26°C).

This unit is installed at the driver's switch panel and provides a means of selecting a temperature range which is then automatically maintained by the action of the thermostat and water valves.

Wiring connections to the heating system thermostat are shown in the wiring diagram included in Section 7 (Electrical) of this manual.

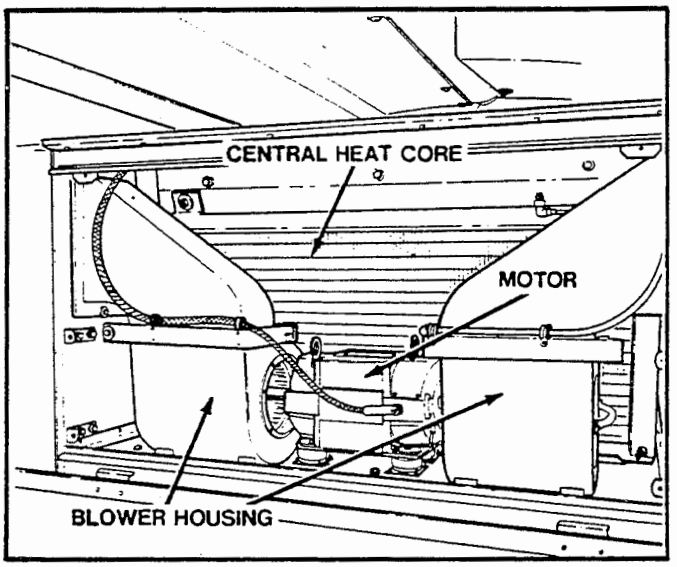


Figure 16-7: C/H Motor and Related Components

A/C & HEATER SWITCH

The A/C-Heating switch is fed from blower cut-in relay when generator is charging.

The selector switch in heat position "A" operates the central heating coach blower at low speed; in A/C position "B", it operates the following:

1) Coach blower operates at high speed.
2) Condenser motor is energized.
3) Compressor unloading solenoid and scavenge solenoid are energized.
4) Condenser blower operates.

AIR CONDITIONING SYSTEM

The air conditioning system is designed to provide a comfortable, healthful atmosphere within the coach. A schematic diagram of the air-conditioning system is illustrated in figure 16-8.

A mixture of cooled, filtered, dehumidified fresh and recirculated air is supplied through wall ducts located below the side windows. The combination of outside and recirculated air is continually filtered, resulting in a clean, fresh atmosphere.

The air is drawn from the coach interior through center aisle ducts. It is filtered, cooled and dehumidified by an evaporator coil, then passed through a temperature-controlled heat core. Two blower fans send the air conditioned air up into the wall ducts.

The system is designed to provide a nominal 7½ tons main A/C and 1 ton driver's A/C of refrigeration or 90,000 Btu per hour (22,700 kcal/h) heat removal.

AIR CONDITIONING CYCLE

Refrigeration may be defined as "the transfer of heat from a place where it is not wanted to a place where it is unobjectionable." The air conditioning system in the coach is the "closed" type system using Freon 12 refrigerant. The major components required for a closed circuit refrigeration system are the compressor, evaporator, condenser, receiver tank and a liquid metering or expansion valve. The following is an explanation of the air conditioning cycle:

1. The refrigerant (Freon gas) flows to the compressor, is compressed to high pressure, and reaches a temperature higher than the surrounding air. It is passed through the air-cooled fins and tubes of the condenser coil causing the hot, high pressure gas to be condensed into a liquid form.

2. The liquid refrigerant flows to the receiver tank, then through a filter-dryer where all moisture, acids and dirt are removed.

3. By its own pressure, the liquid refrigerant flows through a thermostat controlled expansion valve where reduced pressure causes it to become a low temperature, low pressure liquid.

4. The cold, low pressure refrigerant passes through the evaporator coil, absorbs heat from the air passing over the fins and tubes, and changes into gas. In this form, the refrigerant is drawn into the compressor to repeat the air conditioning cycle.

Proper operation of the air conditioning system depends on retaining the conditioned air within the coach. All windows and intake vents should be closed. An opening approximately eight inches square (203.2 mm) could easily neutralize the total capacity of the system.

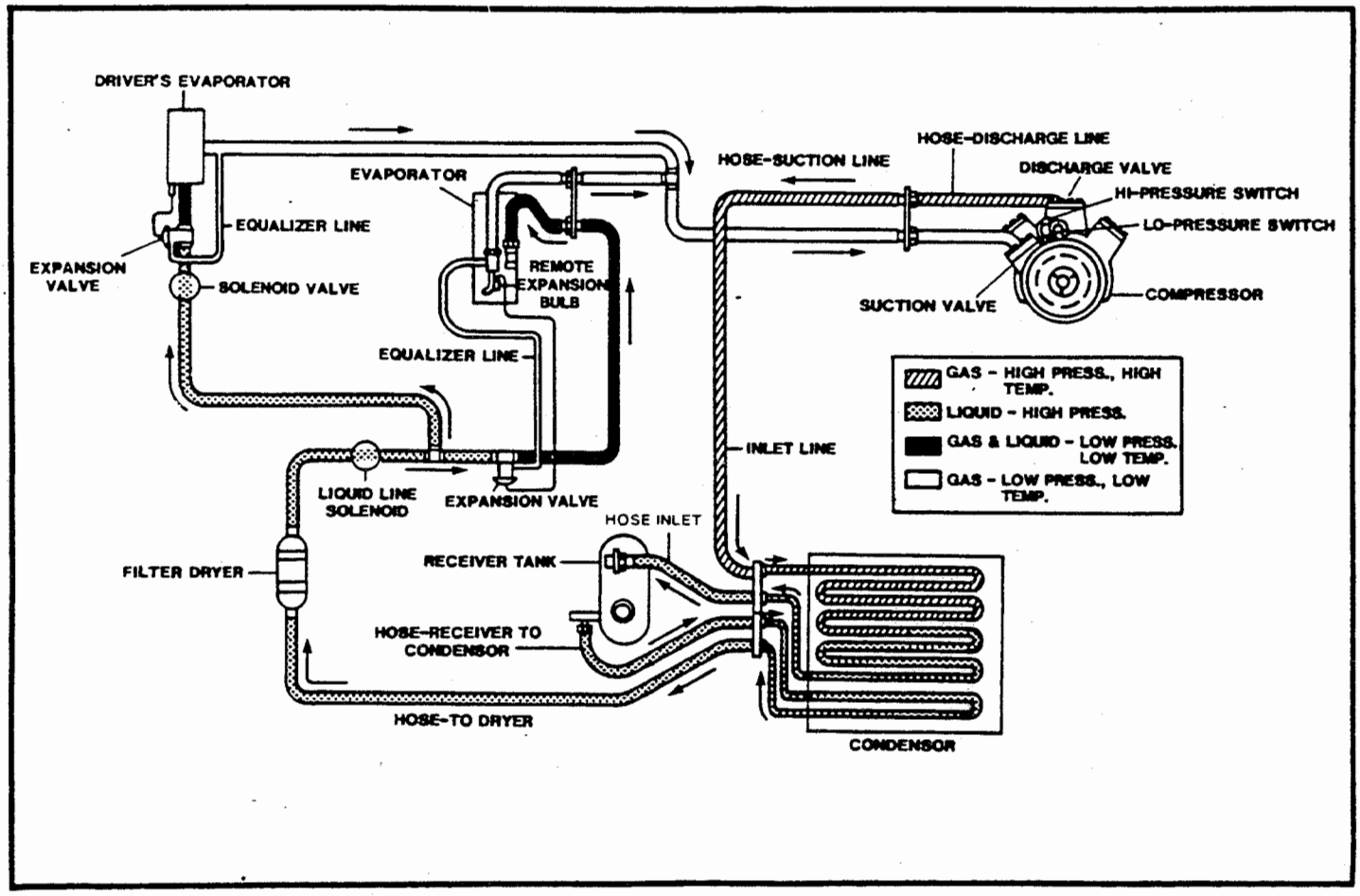


Figure 16-8: Air Conditioning System Diagram

Another cause of inadequate cooling is a dirt-clogged evaporator coil or filter. Dirt acts as insulation and is also a restriction to air flow.

The refrigeration load is not constant and is affected by outside temperature, relative humidity, passenger load, the number of stops, etc. The compressor will load or unload depending on such operating conditions. The following information on the operating conditions is approximate and will vary:

Oil Level in compressor ..... ½ of sight glass
Freon Level in receiver ..... ½ of lower glass
Speed of engine - fast idle ..... 900 rpm

MANUAL SWITCH CONTROLS

Temperature Rheostat - Located on panel to the left of the driver, it controls the air temperature in the coach during both heating and air conditioning.

Passenger A/C Coach Heat - Located on the switch panel to the left of the driver. In "A/C" position, the air conditioning system is energized and functions as required. In the "Off" position, the condenser and evaporator fans are shut off. In the "heating" position, the evaporator fans are at operating speed and the air conditioning compressor is unloaded.

FAST IDLE

The fast engine idle can only be used to power the air conditioning system when the coach is stationary and the emergency parking brakes are applied. The feature consists of a fast idle switch on the driver's switch panel, an air valve in the engine compartment and an air cylinder mounted on the engine governor.

Placing the Fast Idle switch ON energizes the air valve which lets air pressure to the air cylinder, causing the governor-operating lever to be moved to the fast idle position. To eliminate the possibility of engine damage, the accelerator cannot be operated when the fast idle switch is closed.

DAILY CHECKS

1. Check oil level in compressor.
   CAUTION: It is essential that only the correct lubricant be used, such as Texaco WF 68, WFI 132, or equivalent.
2. Check Freon level in receiver.
3. Check and clean condenser coil. Do not use caustic soap.
4. Check and clean filter.
5. Check compressor and belts.

TEST EQUIPMENT

Specific air conditioning test equipment is recommended for routine servicing of the air conditioning system. It includes the following:

Qty.	Part No.	Description
1	16C-2-92	Air Conditioning Test Equipment Kit
1	16C-2-93	Halide Leak Detector (Bernz-o-Matic Model TX-12)
1	16C-2-94	Freon 12, 35 lb. tank (15.9 kg)
3	16C-2-95	Charging Hoses - (Yellow Jacket Hoses) (HCL-36)
1	16C-2-96	Pressure Gauge 0-400 lbs. with R 12 Temperature Scales
1	16C-2-97	Compound Gauge 0-30" Vac. 0-150 lbs. with R 12 Temperature Scales
1	16C-2-98	Gauge Manifold with handwheels
1	16C-2-99	Thermometer - (Mechanical) to check Superheat 10° to +100°F

The above parts are available from Universal Coach Parts Inc., Northlake, Illinois and in Canada from Motor Coach Industries, Service Parts Division.

A/C SYSTEM MAINTENANCE PROCEDURES

AIR CONDITIONING SYSTEM SOLENOID VALVE

When the Passenger A/C-Heat control is switched on, the system solenoid valve is actuated and allows refrigerant to circulate within the air conditioning system. Turning the switch off will close the valve. This valve is located in the condenser compartment.

The valve can be opened or closed manually in case the solenoid's electric operation of driver's switch operation is suspect. Removal of a seal cap on the valve will expose a 3/16" square stem. To manually open the valve, place a wrench on the stem and turn it 180 degrees (½ turn) counterclockwise.

CAUTION: Turn only 180° counterclockwise. Do not backseat.

To manually close the valve, turn the stem ½ turn clockwise until the stem is tight (seated).

NOTE: The manual stem must be in the closed position before automatic solenoid operation will take place.

PUMPING DOWN

Whenever it is necessary to "open" the refrigeration system for service or repairs, the refrigerant must be removed from that part of the system requiring service. Localizing refrigerant into one part of the system (usually the receiver) is known as "pumping down." The procedure is as follows:

1. Close the outlet valve on the receiver, backseat the suction valve, install a gauge and turn the valve forward ¼ turn, thus enabling visual check of the suction pressure.
2. Connect a jumper wire between horizontal studs 1 and 2 in remote control box

NOTE: This jumper will allow the compressor clutch to remain engaged after pressure drops below 15 psi (103.5 kPa).

3. Start the engine and operate the compressor until pressure reads 1-2 psi (6.9-13.8 kPa), then disconnect the jumper wire.
4. The pressure will probably rise. Install jumper wire again and lower the pressure until it remains at 1 or 2 psi (6.9-13.8 kPa). Close inlet valve to receiver tank. Stop compressor.

5. Close the discharge valve at the compressor.
6. Close the suction valve at the compressor.

CAUTION: During this operation care must be taken not to fill the receiver tank over the top sight glass. It may be necessary to partially vent the tank. Always allow refrigerant piping and system components to warm up to the ambient air temperature before opening system or sweating will take place inside the lines with resultant system contamination.

ADDING REFRIGERANT

Always charge the system with the Freon cylinder upright and the valve on top to avoid drawing liquid out of the cylinder. When charging an empty system, weigh the amount of Freon put into the system. This will eliminate any possibility of overfilling. A full charge is exactly 24 pounds (10.8 kg).

To add Freon to the system:

1. Backseat the suction service valve on the compressor and loosely connect a charging line from the Freon cylinder to the valve.
2. Tighten the connection at Freon cylinder and open the tank end slightly to purge air from the charging line.
3. Tighten the charging line connection at the compressor.
4. Screw the stem of the suction valve in approximately two turns.
5. Start the engine (compressor) and run at fast idle. Add sufficient Freon to bring the level in lower sight glass in receiver tank to mid-point.

AIR IN SYSTEM

The presence of air in the air conditioning system may be determined by the following test procedure. To check for air, the system must be off and cooled to ambient temperature:

1. Connect test gauges to A/C compressor and record suction pressure and discharge pressure (head pressure).
2. Compare the readings. If the difference between the two readings is greater than 5 psi (34.5 kPa), air is present and the system should be purged.
3. If the difference between suction and discharge pressure is within 5 psi, connect a gauge to the test fitting on the main expansion valve and record the pressure. Compare this reading with the suction pres .
4. Check the pressure on the d s expansion valve in the same manner. Compare the reading with the suction pressure.
5. If there is more than a 5 psi (34.5 kPa) difference between suction pressure and either expansion valve pressure, air is present and the system should be evacuated.

EVACUATION OF AIR CONDITIONING SYSTEM

1. Connect service gauges and backseat both the suction and discharge valves on the compressor.
2. Remove protective caps from the service gauge pressure tap ports on the suction and discharge valves.
3. Connect the gauge hoses loosely to the compressor suction and discharge valves.
4. Connect the line from the gauge manifold to the vacuum pump. Connection should be tight.
5. Midseat the valves at the high and low sides of the service gauge manifold.
6. Open the suction and discharge service valves slightly to allow any Freon that might be remaining in the system to escape to the atmosphere.
7. When you can no longer detect Freon gas escaping, tighten the service hose connections.
8. Midseat the suction and discharge service valves.
9. Start vacuum pump and run until pressure in the system is from 29.5 to 29.7 In-Hg, then run 4 to 5 minutes longer.

To check the system, proceed as follows:

10. Close valve between manifold and pump.
11. Shut off pump and wait 15 minutes. If the pressure rises no more than 2 psi during that time period, the system is dry and free of leaks. If the pressure rises more than 2 psi and stops, it indicates there is moisture remaining in the system and further evacuation is required. (Repeat steps 9-11.) If the pressure rises more than 2 psi and continues to rise, it indicates a leak in the system.
12. If there are no leaks or moisture in the system, close the suction and discharge service valves on the compressor.

To remove gauges, proceed as follows:

13. Start engine and compressor.
14. Backseat compressor discharge service valve.
15. Backseat both high and low side hand valves of gauge manifold with discharge service valve backseated.
16. Backseat compressor suction valve.
17. Shut engine off.
18. Remove the hoses from the compressor.

NOTE: If hoses are attached to dummy fittings on back of manifold, there will be enough refrigerant left in the lines to give a slight positive reading to prevent dirt and moisture from entering the gauges.

CHARGING THE SYSTEM

When a system has been opened or if there is any question about the air or moisture in the system, evacuate the system. Charging of an evacuated system may be accomplished by forcing liquid Freon 12 directly into the receiver tank.

This may be accomplished by placing the refrigerant tank upside down on a scale (bathroom type) with valving at the bottom and liquid charging. This ensures that only liquid enters the reservoir.

1. Backseat the two compressor shut-off valves (out).
2. Install the test gauges at the shut-off valves noting that the 400 psi (2.758 kPa) gauge is connected to the discharge.
3. Turn in the two shut-off valves 3 to 4 turns.
4. Open the lower receiver valve by turning all the way out.
5. Backseat the upper receiver valve by turning all the way out.
6. Remove the cover cap from the service fitting in the top receiver valve.

7. Attach a charging hose to the Freon tank. Open the tank valve slightly permitting Freon to escape thus purging the hose of air.

8. Connect the charging hose to the service fitting.

9. Open the Freon tank valve.

10. Turn in the upper receiver valve several turns. The Freon will now enter the system.

11. The proper charge of Freon is 24 pounds (10.9 kg).

12. When the scale indicates this amount of charge, backseat the receiver valve and close the Freon tank valve.

13. Disconnect the charging hose. Replace the cover caps.

14. The system is now ready for operation.

LUBRICATION

Too much oil in the system is as harmful as too little. To ensure proper lubrication, the level should be maintained within certain limits.

Sight gauges are located on both sides of compressor crankcase. Oil level is correct when engine side sight gauge is full and curb side sight gauge is empty.

After standing idle for any length of time, the compressor will normally pump crankcase oil into the system and approximately 20 minutes of running time may be required to bring it back to the crankcase.

After the unit has run at least one-half hour, the crankcase temperature should be warm to touch. If cool, this indicates ne expansion valve adjustment is passing too much liquid or there is excessive oil in the system. Oil level is always lower in a cool crankcase due to cooling evaporating refrigerant causing oil to foam and be carried out into the system.

BELT TENSION

AIR CYLINDER

An air-operated conditioning compressor belt tension air cylinder is installed to keep the correct tension of A/C compressor drive belts. Access to the air cylinder can be gained through rear engine compartment doors. See figure 16-9.

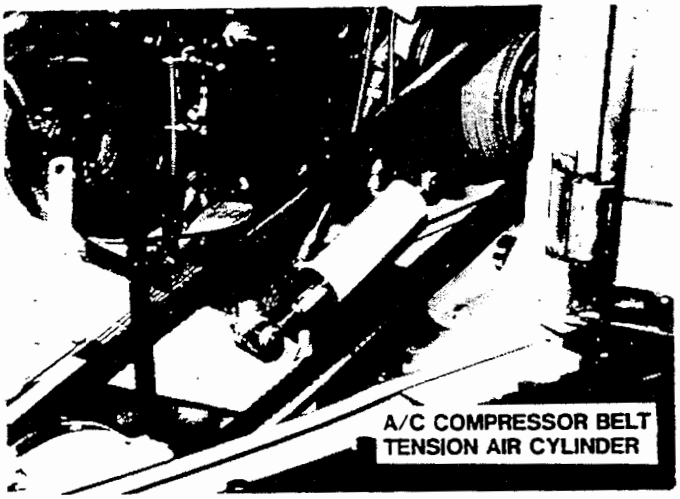


Figure 16-9: Belt Tension Cylinder

MAINTENANCE - The A/C compressor belt tension air cylinder should be lubricated at regular intervals, approximately every 30,000 miles (48,000 km).

The recommended procedure is as follows:

1. Remove air feed hose from cylinder and apply a few drops of SAE 30 or 40 engine oil into cylinder hose connector.

2. Reconnect the hose, then reverse the air supply to the cylinder to lubricate the other end of the cylinder.

3. Check the cylinder for air leaks and recondition it as required.

NOTE: Do not attempt to disassemble air cylinder in coach.

REMOVAL AND DISASSEMBLY - Proceed as follows:

1. Shut off air supply by turning control valve handle to compress the cylinder spring and relieve belt tension.

2. Remove drive belts.

3. Remove lock nuts and bolts securing rod ends to mounting bracket on the engine cradle, and bracket on compressor. Remove air cylinder from coach.

4. Disconnect feed and exhaust hoses at the air cylinder.

5. Remove the uniball ends from air cylinder assembly.

WARNING: Air cylinder end plate is under 50 to 60 lbs. (22.6-27.2 kg) spring pressure. Care must be exercised to avoid injury when disassembling the cylinder.

6. Using an arbor press, depress the piston rod into the cylinder approximately ½" (12.7 mm) before attempting to remove retaining ring.

CAUTION: Avoid depressing piston rod beyond ½" (12.7 mm) as spring pressure increases with more compression. Care should be taken not to damage any threaded surfaces.

7. Remove end plate retaining ring using a suitable pliers and screwdriver if necessary.

8. Slowly release pressure on piston rod and cylinder assembly thus allowing the end plate to come clear of cylinder.

9. Internal parts can now be removed for cleaning and inspection. See figure 16-10.

INSPECTION AND REPLACEMENT - Inspect all O-rings, cups, felts and seals; replace if damaged. Inspect cylinder bore and piston for scoring and replace if damaged. Refer to Specifications at end of this section for spring rate tension and replace if not within tolerances. Inspect retaining ring and replace if bent or damaged.

REASSEMBLY - follow this procedure:

1. Coat all new parts with SAE 30 or 40 engine oil prior to assembly.

2. Reassemble the cylinder in reverse order of disassembly.

3. Hold the cylinder in an upright position and install the spring and oil felt in position over the boss on the lower end

MC-9 MAINTENANCE MANUAL

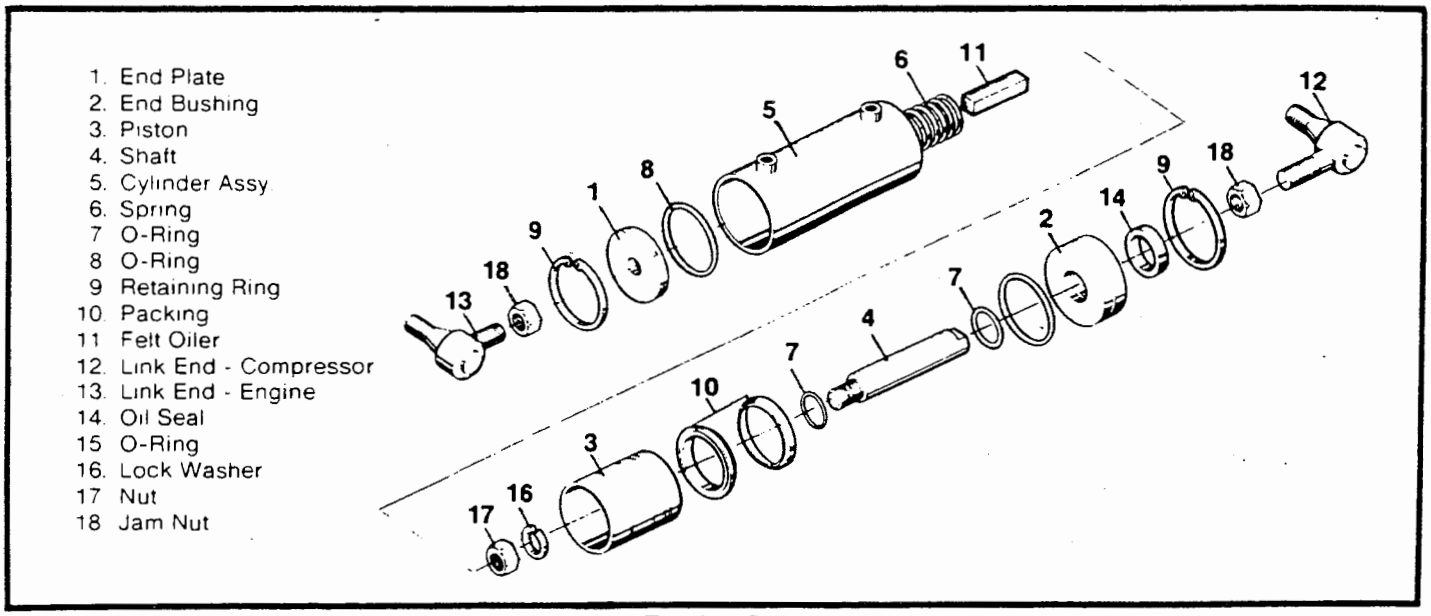


Figure 16-10: Belt Tension Cylinder Components

plate. The same applies when piston assembly and end plate are installed.

4. Place in vice or arbor press. Apply pressure against piston rod. Be careful not to damage seal.

5. Compress end plate approximately 1/16" (1.5 mm) beyond retaining ring groove and install retaining ring.

CAUTION: Care must be taken at assembly not to allow piston rod or air cylinder to slip out of vice or arbor press.

INSTALLATION AND ADJUSTMENT - Proceed with these steps:

1. Install A/C compressor air cylinder belts. Assemble lock nuts and bolts securing rod ends to mounting bracket on engine cradle and bracket on compressor.

2. Connect feed and exhaust hoses.

3. Turn control valve handle to ON position.

4. Check the extension of the actuating shaft of the air cylinder. It should be 1¼ ± ⅛" (31.7 ± under recommended air pressure from the air pressure regulating valve (discussed below).

NOTE: Shaft extension should be as specified in step 4 regardless of the length of the belts.

5. If shaft extension requirement is not as specified, loosen shaft jam nuts and adjust to achieve the specified extension. Tighten the jam nuts.

Follow the above procedure when new belts are installed. After 500 miles (800 km) check the shaft extension dimension and readjust as necessary. Refer to Belt Tension Pressure Regulating Valve (following) for air pressure adjustment.

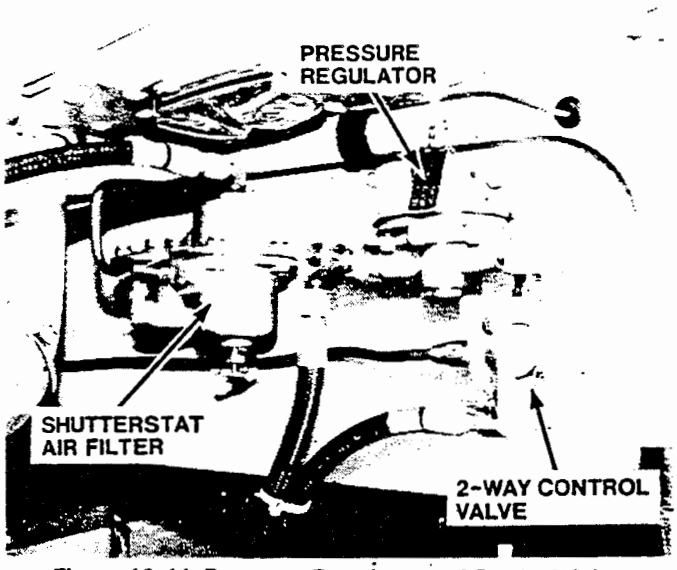


Figure 16-11: Pressure Regulator and Control Valve

BELT TENSION PRESSURE REGULATING VALVE

An air pressure regulating valve provides belt tension air pressure to prevent belt drive slippage. See figure 16-11. The required air pressure from the regulator is 95 psi (655 kPa). Perform this procedure to adjust the belt tension pressure regulator valve:

1. Install an air pressure gauge between the regulating valve and the belt tightener air cylinder.

2. Turn 2-way control valve to off and on positions several times and observe pressure reading on gauge.

3. If final pressure reading is not 95 psi, loosen lock nut at top of regulating valve.

4. If pressure is higher than 95 psi, turn regulator adjusting screen counterclockwise and turn 2-way valve to off and on several times. When reading is less than 95, proceed to step 5.

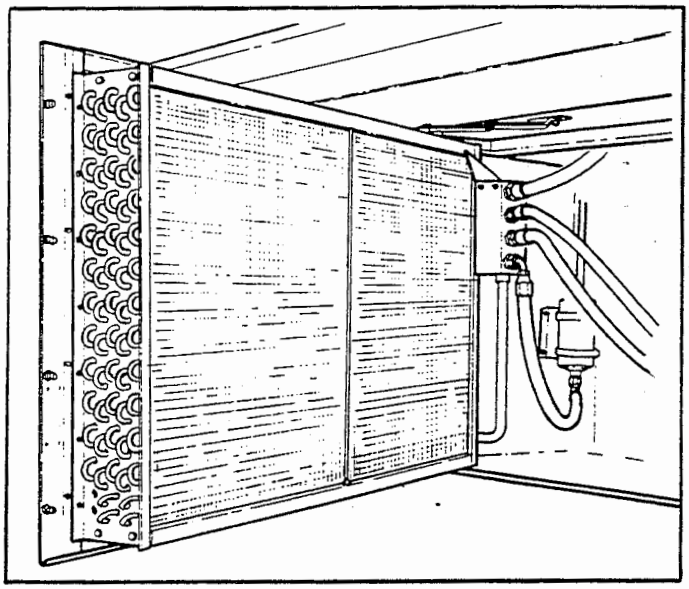


Figure 16-12: Air Conditioning Condenser Coil

5. While observing air pressure gauge, turn adjusting screw clockwise until the required 95 psi (655 kPa) reading is reached. Tighten the lock nut.

6. Remove air pressure gauge and reconnect lines.

CONDENSER

The condenser compartment is located on the left side of the coach, behind the front wheel housing and contains the coil, fan and housing blower motor, receiver tank and controls.

The condenser coil is mounted on the inner side of the compartment door. Since the condenser's purpose is to dissipate the heat from the hot refrigerant, it is important to keep the cooling coils and fins clean. See figure 16-12.

Dirt and grease clogging the coil causes high head pressure and reduced system efficiency. It is important to clean the condenser coil regularly, preferably once a day, using water under pressure directed at the inside surface of the core.

Flush the condenser coil from inside out, using a water jet or water mixed with air pressure. Direct the pressure straight through the coil to prevent bending of fins.

For an extremely dirty coil, use Kelite 28 as a cleansing agent. Mix with cold water and wash the coil. Rinse with cold water.

CAUTION: Do not use a high pressure water jet, steam or harsh soaps.

EVAPORATOR

The evaporator is located in the heating/cooling compartment behind the heater core (when viewing from front baggage compartment). See figure 16-13. (The heater core and fan assembly can be checked by opening the center door in the front baggage compartment.)

The evaporator can be checked and cleaned by removing the access panel at the rear of the condenser compartment on the rear bulkhead. Periodic cleaning is required to ensure full efficiency. The evaporator should be cleaned with a cleansing agent not harmful to aluminum or copper. Also keep the compartment seals in weathertight condition to assure proper coach air circulation.

To remove the evaporator, it is necessary to remove the fans and ducts, the heater core and then the evaporator and frame as one assembly.

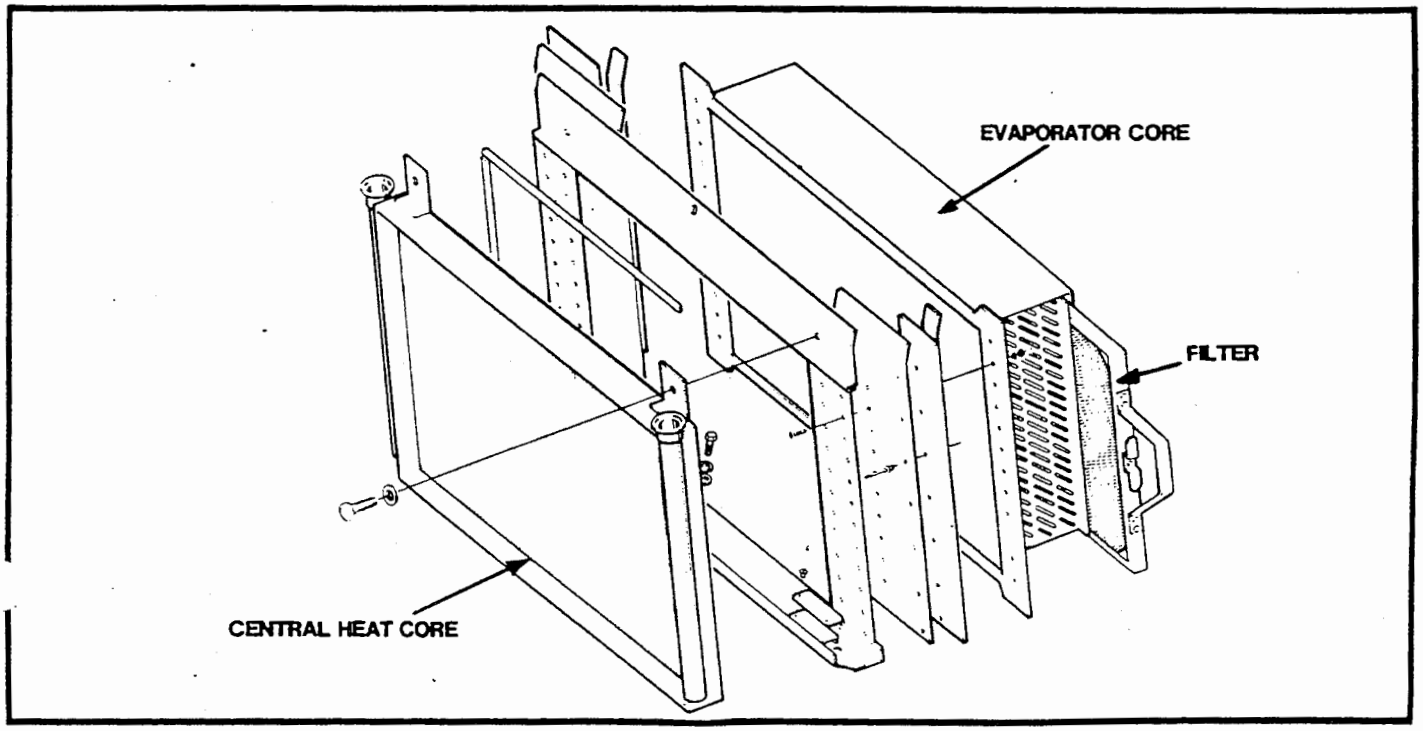


Figure 16-13: Evaporator and Heater Cores

FANS AND MOTOR

Evaporator blowers are mounted on the shafts of a 1½ hp (1.1 kw) 24-volt motor. They should be cleaned periodically, the frequency depending on operating conditions. A dusty environment will mean more frequent cleaning. Use compressed air to clean the fans.

The motor (single speed) should be checked every 5,000 operating hours (more often in dusty environments). Lubrication is not necessary since the motor is a sealed, self-lubricated unit. However, the brushes should not be allowed to wear shorter than ¾" (19 mm).

To test the current draw of the motor, proceed as follows:

1. Connect an ammeter in series with the motor lead. The ammeter hook-up must allow the evaporator door to be fully closed during the check.
2. Start the engine and set at fast idle.
3. Place the A/C-Heat Switch in the A/C position.
4. Observe the ammeter reading. Current draw should be 48-52 amps at 27.2 VDC.
5. Check and replace the motor brushes if motor draws excessive current. Minimum brush length is ¾" (19 mm).

CAUTION: Do not use emery cloth or sandpaper for seating brushes or cleaning commutators. Seat new brushes with a bedding stone.

6. If the brushes are satisfactory, replace the motor.

NOTE: Fans and tapered lock bushings are dynamically balanced. Before removing the bushing, match-mark the fan and bushing to allow re-installation in the same position.

FILTER

At intervals depending on service conditions, the A/C air filter should be removed and the following procedure followed for cleaning:

1. Shake out excessive dirt and grit.
2. Wash in warm water and if excessively dirty, use a mild laundry detergent in warm water.
3. Rinse thoroughly and shake out excess water.
4. Let dry and replace in service.

To reach the filter, open the battery compartment door, unlatch locks and pull out filter. The filter is provided with a grab handle for removal. See figure 16-1.

CAUTION: The coach should never be operated without this filter because proper circulation would be impaired. All air would bypass from pressure to the suction side of the chamber.

RECEIVER TANK

The receiver tank is located in the condenser compartment. The sight glasses can be observed by opening the condenser compartment door (figure 16-14).

The function of the receiver tank is to store the liquid refrigerant. During normal operation, the level of the refrigerant should be approximately at the halfway mark on the lower glass.

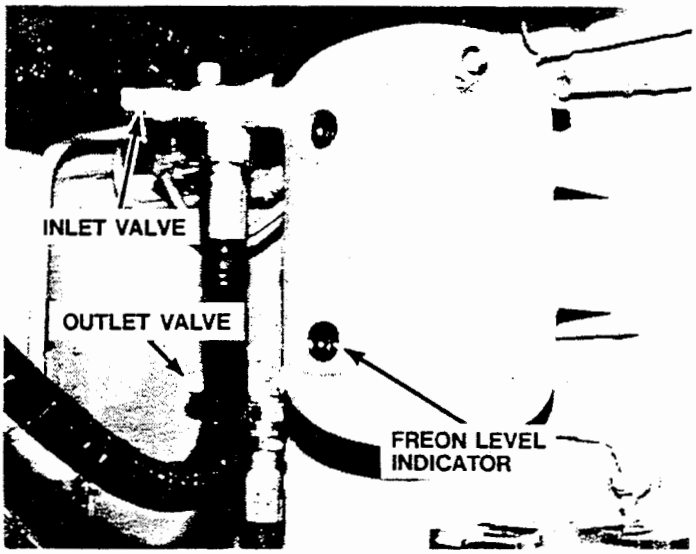


Figure 16-14: Receiver Tank

In case of extreme pressure rise in the liquid receiver tank, a pressure relief valve will break at 385 psi ± 10 psi (2,655 kPa ±69 kPa), and relieve the receiver tank pressure.

The receiver tank incorporates an inlet valve at the inlet side which allows the tank to be isolated for service. An outlet valve at the outlet side permits complete isolation from the rest of the system.

PURGING SYSTEM AT RECEIVER TANK

Abnormal high head pressure sometimes indicates non-condensible gases in the receiver tank. In order to purge such gases that might accumulate in the system, use the test gauge fitting on the intake valve to purge the receiver tank.

The system requires 24 lbs. (10.8 kg) of Freon 12. The liquid should be approximately ½ in lower sight glass after 30 minutes of engine operation in fast idle with coach interior at approximately 70°F. (21°C.).

Refrigerant liquid should never be visible in upper sight glass and refrigerant should not be added unless the system has been operated as previously outlined.

FILTER-DRYER

A filter-dryer (figure 16-15) is installed between the receiver tank and expansion valve. It is used to absorb moisture from the refrigerant.

A plugged filter-dryer is indicated by differences in temperature on either side of it. If plugged, the filter-dryer must be replaced by following this procedure:

1. Pump down the system by isolating the refrigerant in the receiver and reducing pressure at the dryer.
2. Install a service gauge at the compressor.
3. Close off the outlet from the receiver tank.
4. Run the compressor until the low side of the system is evacuated.
5. Change the filter-dryer element.

6. Admit a small quantity of Freon to the low side of the system. Check for leaks. Return the system to normal operation.

CAUTION: Use mineral spirits to clean parts. Do not use carbon tetrachloride or similar solvent. Do not use white gasoline or naphtha due to flammability hazard. Do not steam clean.

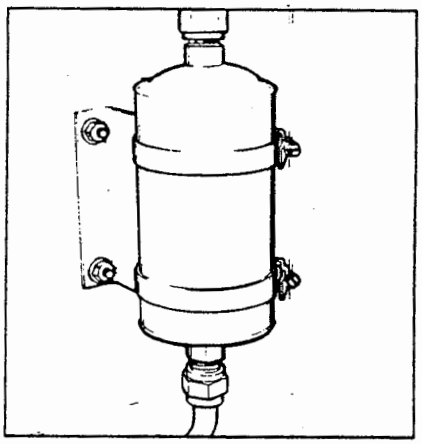


Figure 16-15: Filter/Dryer

LIQUID LINE SOLENOID VALVES

A solenoid valve is installed in the freon line going to the passenger A/C evaporator and in the line to the driver's A/C evaporator (figures 16-16 and 16-17). The valve is installed ahead of the expansion valve and is energized by the appropriate A/C switch on the driver's upper L.H. switch panel. When energerized, the solenoid valve opens and allows freon to flow to the expansion valve.

Whenever the A/C system is being serviced, or when an insufficient cooling problem is being investigated, this valve should be checked to determine if it is opening so that freon is able to circulate through the system. If the valve is not functioning properly, check the electrical connections to it and check for damage to the wiring. Refer to the heating and air conditioning schematic which may be found in Section 7 of this manual.

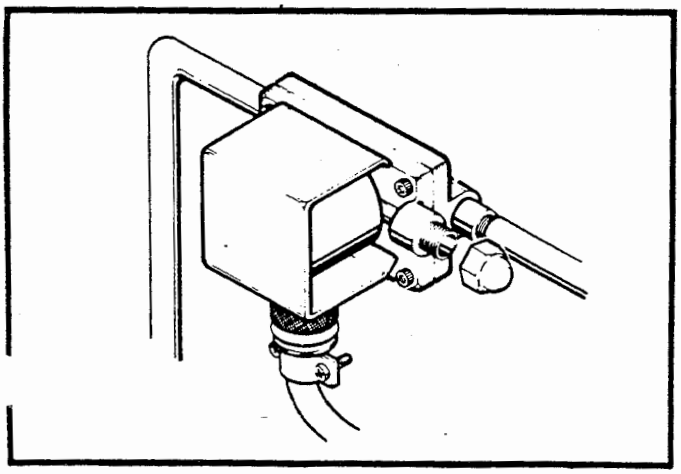


Figure 16-16: Liquid Line Solenoid Valve in Condenser Compartment

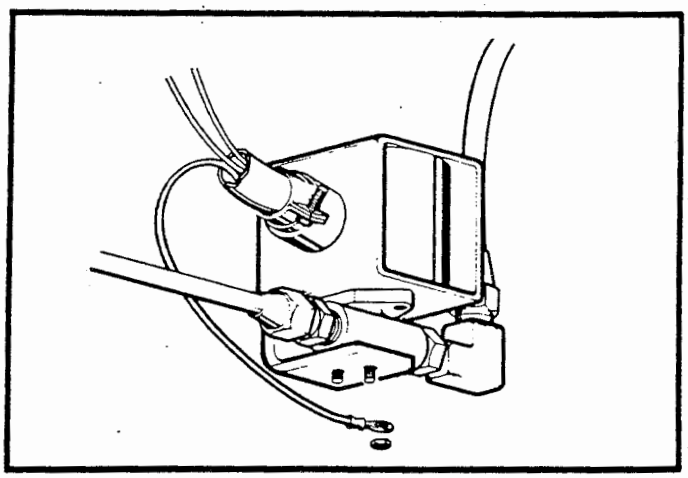
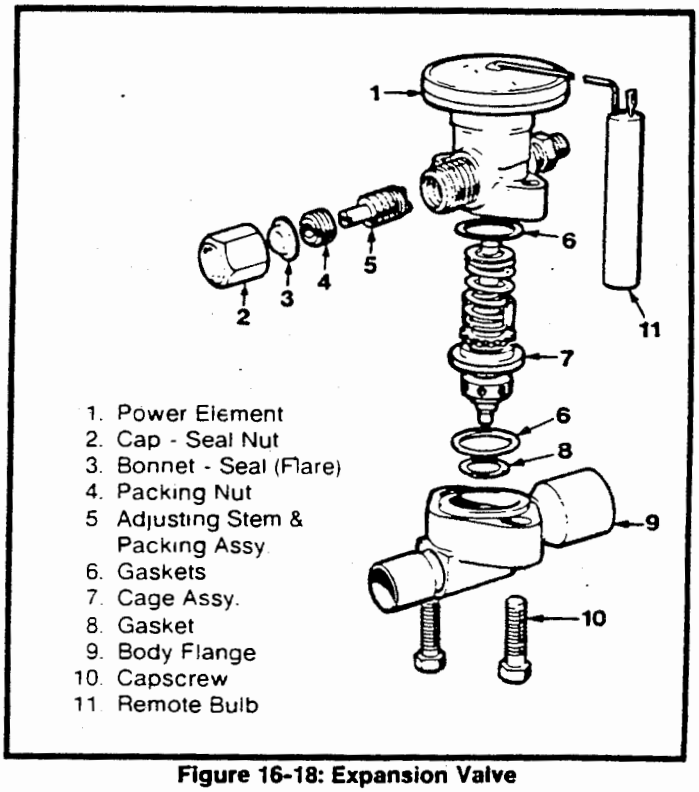


Figure 16-17: Liquid Line Solenoid Valve at Driver's Evaporator

EXPANSION VALVE

The expansion valve (figure 16-18) is a thermo-sensitive valve with a remote control bulb attached to the evaporator outlet line. The valve regulates the flow of liquid refrigerant into the evaporator coils depending on the suction gas temperature leaving the evaporator.



1. Power Element
2. Cap - Seal Nut
3. Bonnet - Seal (Flare)
4. Packing Nut
5. Adjusting Stem & Packing Assy
6. Gaskets
7. Cage Assy.
8. Gasket
9. Body Flange
10. Capscrew
11. Remote Bulb

Figure 16-18: Expansion Valve

The remote bulb senses the gas refrigerant temperature as it leaves the evaporator. High temperature will cause expansion and pressure on the power head and spring. Such action causes the power assembly valve to open, allowing a flow of liquid refrigerant into the evaporator.

OPERATION - The remote bulb and power assembly is a closed system. The pressure within the remote bulb and

power assembly corresponds to the saturation pressure of the refrigerant temperature leaving the evaporator and moves the valve pin in the opening direction. Opposed to this force on the underneath side of the diaphragm and acting in the closing direction, is the force exerted by the evaporator pressure, and the pressure exerted by the superheat spring. As the temperature of the refrigerant gas at the evaporator outlet increases above the saturation temperature corresponding to the evaporator pressure, it becomes superheated. The pressure thus generated in the bulb and power element increases above the combined pressures of the evaporator pressure and the superheat spring, causing the valve pin to move in the opening direction. Conversely, as the temperature of the refrigerant gas leaving the evaporator decreases, the pressure in the bulb and power assembly also decreases and the combined evaporator and spring pressures cause the valve pin to move in the closing position.

As the operating superheat is raised, the evaporator capacity decreases, since more of the evaporator surface is required to produce the superheat necessary to open the valve. It is most important to adjust the operating superheat correctly. A minimum change in superheat required to move the valve pin to full open position, is of vital importance because it provides savings in both initial evaporator costs and cost of operation. Accurate and sensitive control of the liquid refrigerant flow to the evaporator is necessary to provide maximum evaporator capacity under all load conditions.

The spring is adjusted to give 8°-12°F. (5°-7°C.) of superheat at the evaporator outlet. This ensures the refrigerant leaving the evaporator is in a completely gaseous state when drawn into the suction side of the compressor. Liquid would damage the compressor valves, pistons and heads if allowed to return in the suction line.

Vapor is superheated when its temperature is higher than the saturation temperature corresponding to its pressure. The amount of the superheat is, of course, the temperature increase above the saturation temperature at the existing pressure.

As the refrigerant moves along in the evaporator, the liquid boils off into a vapor and the amount of liquid decreases until all the liquid has evaporated due to the absorption of a quantity of heat from the surrounding atmosphere equal to the latent heat of vaporization of the refrigerant. The refrigerant gas continues along in the evaporator and remains at the same pressure; however, its temperature increases due to the continued absorption of heat from the surrounding atmosphere. The degree to which the refrigerant gas is superheated is a function of the amount of refrigerant being fed to the evaporator and the load to which the evaporator is exposed.

CAUTION: If the expansion valve is suspected of being out of adjustment, check the A/C system for a restricted suction line, plugged filter-dryer or a partially open valve before conducting this procedure.

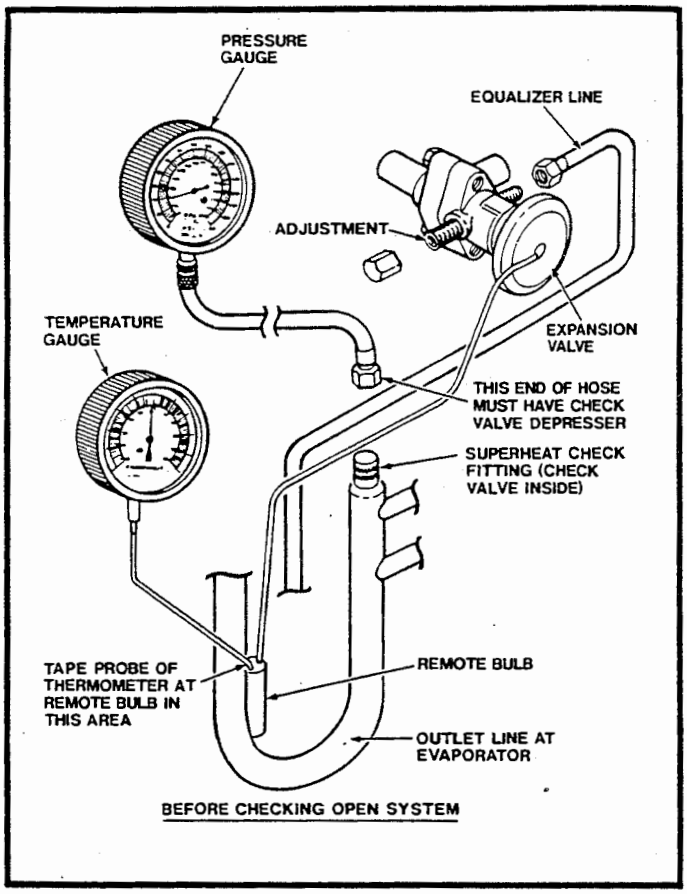

PRESSURE GAUGE
EQUALIZER LINE
ADJUSTMENT
TEMPERATURE GAUGE
EXPANSION VALVE
THIS END OF HOSE MUST HAVE CHECK VALVE DEPRESSER
SUPERHEAT CHECK FITTING (CHECK VALVE INSIDE)
TAPE PROBE OF THERMOMETER AT REMOTE BULB IN THIS AREA
REMOTE BULB
OUTLET LINE AT EVAPORATOR
BEFORE CHECKING OPEN SYSTEM

Figure 16-19: Gauges Installed for Superheat Adjustment

SUPERHEAT ADJUSTMENT - Fittings are provided on both evaporators to adjust superheat temperature. Before checking the superheat in either the driver's or the main evaporator, turn the respective evaporator expansion valve adjustment control full counterclockwise and then 11 full turns clockwise. Perform the following procedure to adjust the superheat setting of the expansion valves:

1. Operate coach engine for at least one-half hour at fast idle with temperature controls set at 82°F. (28°C.).

2. Refer to figures 16-19 and 16-20. Install a pressure gauge at the fitting of the evaporator expansion valve. The hose end with the checkvalve depressor is connected to the fitting with the valve stem.

3. Install a remote reading thermometer to the evaporator outlet near the existing remote bulb. Refer to the illustrations. Thermostatic tape must be wrapped around the bulb, evaporator outlet line and gauge probe to get a true reading of the line temperature.

4. Over an 8-minute operating period, check and record the following gauge readings:

a. At 2-minute intervals record the pressure reading and the temperature reading (figure 16-21).

b. Record the highest temperature reading (during the 8 minutes) and the lowest temperature reading.

5. Refer to the Pressure-to-Temperature Chart. For each *pressure reading* recorded (a in step 4), record the equivalent temperature. Example:

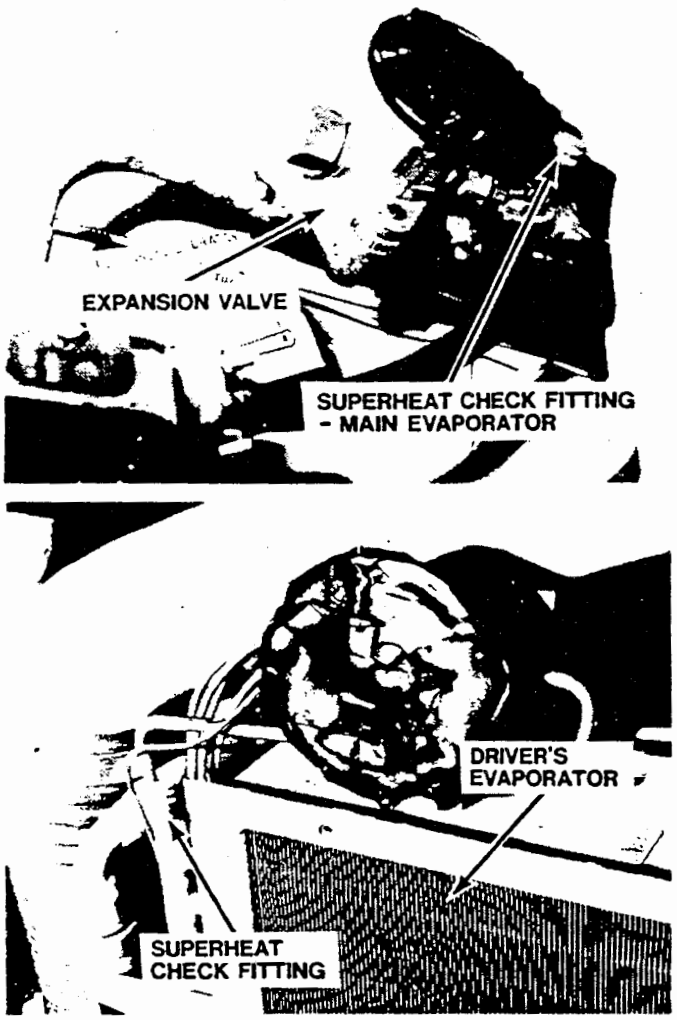


Figure 16-20: Superheat Check Fittings for Pressure Gauge Connection

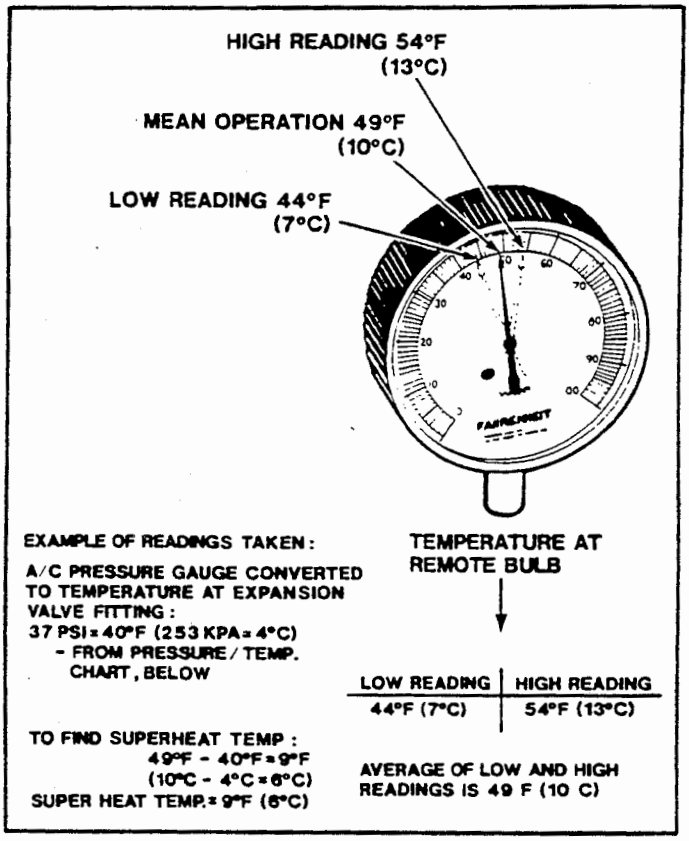

HIGH READING 54°F (13°C)
MEAN OPERATION 49°F (10°C)
LOW READING 44°F (7°C)
EXAMPLE OF READINGS TAKEN:
A/C PRESSURE GAUGE CONVERTED TO TEMPERATURE AT EXPANSION VALVE FITTING:
37 PSI = 40°F (253 KPA = 4°C)
- FROM PRESSURE / TEMP. CHART, BELOW
TEMPERATURE AT REMOTE BULB
LOW READING 44°F (7°C)
HIGH READING 54°F (13°C)
TO FIND SUPERHEAT TEMP:
49°F - 40°F = 9°F
(10°C - 4°C = 6°C)
SUPER HEAT TEMP. = 9°F (6°C)
AVERAGE OF LOW AND HIGH READINGS IS 49 F (10 C)

Figure 16-21: Temperature Gauge Readings

Standard Units	Metric Units
36 psi = 39°F	247 kPa = 4°C
37 psi = 40°F	253 kPa = 4°C
41 psi = 44°F	281 kPa = 7°C
39 psi = 42°F	267 kPa = 6°C

6. Determine the average equivalent check fitting temperature by adding the four temperatures and dividing the sum by four. Example:

39°F	4°C
+40	+4°C
+44	+6°C
+42	+7°C
TOTAL: 165°F	21°C
165 ÷ 4 = 41°F Average	21 ÷ 4 = 5.25°C Average

7. Determine the average remote bulb temperature from the high and low *temperature* readings recorded (b in step 4). Example:

High Reading: 54°F (12°C)
Plus Low Reading: +44 (8°C)
Total: 98°F (20°C)

Divide by 2: 98 ÷ 2 = 49°F (20 ÷ 2 = 10°C Average)

8. Subtract the lowest equivalent temperature recorded at the check fitting from the lowest temperature from the temperature gauge. The answer (difference) is the superheat temperature. Example:

Lowest Remote Bulb Temperature: 44°F (8°C)
Subtract Lowest Equivalent Temperature: -39°F (4°C)
Superheat Temperature: 5°F (4°C)

The superheat temperature should be a minimum of 4°F (2°C). If less than 4°F (2°C), the expansion valve should be adjusted (see step 10) and the entire procedure repeated.

NOTE: If the expansion valve needs adjustment at this point, proceed to step 10.

9. Subtract the average equivalent temperature (from step 6) from the average remote bulb temperature (from step 7). Example:

Avg Temp. at Bulb: 49°F (10°C)
Subtract Avg Equiv. Temp. at Fitting: -41°F (5.25°C)
Difference: 8°F (4.75°C)

The difference in the average temperatures should be from 10-12°F (5-6°C). If more than 12°F (6°C) or less than 10°F (5°C), as in the example, the expansion valve requires adjustment (see step 10) and the entire procedure should be repeated.

CAUTION: Before adjusting the expansion valve, check for a restricted suction line, plugged filter dryer or for a partially opened valve.

To verify the need for expansion valve adjustment perform steps 10-17.

10. Remove the gauges from the expansion valve and install them at the compressor gauge connections; pressure gauge in suction line and temperature gauge installed to indicate suction line temperature.

11. Run the system for 10 minutes, set at 82°F (28°C).

12. Measure and record the line pressure and temperture.

13. Determine equivalent temperature from the chart. Example: 30 psi (206 kPa) equals 32°F (0°C).

14. Subtract the equivalent temperature from the line temperature indicated on the temperature gauge. Example:

Temperature Gauge Reading: 40°F (4°C)
Subtract Equivalent Temperature: -32°F (0°C)
Answer: 8°F (4°C)

15. The answer represents the indicated superheat. If this temperature is approximately equal to the superheat temperature determined in step 8, above, there is no apparent restriction in the suction line or filter dryer, nor an open valve. Proceed to step 17.

16. If the answer (step 14) is not approximately equal to the superheat temperature determined in step 8, determine the cause of the different readings (e.g. suction line restriction, clogged filter dryer or malfunctioning valve) and repair the defective part. Repeat steps 1-16 to determine need for expansion valve adjustment.

17. To adjust the superheat setting on the expansion valve, turn the adjustment screw clockwise to increase superheat temperature, counterclockwise to lower superheat temperature.

18. Repeat steps 2 thru 9 to verify correct valve setting.

MAINTENANCE -

1. Pump down the system as directed earlier in this section.

2. See figures 16-19 and 16-20. At the expansion valve, disconnect the external equalizer line from the underside of the power head and unclamp the remote control bulb from the evaporator coil outlet line.

PRESSURES AND EQUIVALENT TEMPERATURES (FREON 12)

STANDARD UNITS		METRIC UNITS		STANDARD UNITS		METRIC UNITS	
PSI	°F	KPA	°C	PSI	°F	KPA	°C
25	28	171	-2	48	51	329	11
26	29	178	-2	49	52	336	11
27	30	185	-1	50	53	343	12
28	31	192	-1	51	54	349	12
29	32	199	0	52	55	356	12
30	33	206	1	53	56	363	13
31	34	212	1	54	57	370	13
32	35	219	2	55	58	377	14
33	36	226	2	56	59	384	14
34	37	233	3	57	60	390	15
35	38	240	3	58	60	397	16
36	39	247	4	59	61	404	16
37	40	253	4	60	62	411	16
38	41	266	5	61	63	418	17
39	42	267	6	62	64	425	17
40	43	275	6	63	64	432	18
41	44	281	7	64	65	438	18
42	45	288	7	65	66	445	18
43	46	295	8	66	67	452	19
44	47	301	8	67	68	459	19
45	48	308	9	68	68	466	20
46	49	315	9	69	69	473	21
47	50	322	10	70	70	480	21

3. Remove the two capscrews holding the power assembly to the valve body flange. Lift off the power assembly and remove the cage assembly.

4. Thoroughly clean all parts with mineral spirits and stiff bristle (not steel) brush. Dry thoroughly with compressed air.

CAUTION: Do not use gasoline, nephtha, carbon tetrachloride or similar solvent to clean parts. Do not use steam or caustic materials for cleaning.

5. Inspect all parts for wear, pitting, scoring, cracks or distortion. Remote bulb and connecting tube must be free of cracks, holes, kinks and cuts.

When reassembling, replace with new gaskets in proper place. Be sure the two lugs on the cage assembly fit into grooves provided in the power assembly. Do not force the valve together. The cage must fit properly before tightening the body flange. Tighten bolts evenly.

CAUTION: If necessary to make a soldered connection, first remove the power and cage assemblies and all gaskets. Keep heat away from all parts except the body flange, particularly the remote control bulb and tube.

SOLDERING -Before soldering any part of the system, make sure the area is well ventilated. Use (Stay-Clean) flux sparingly and apply solder (95-5 round wire ⅛" (3.1 mm)). After completing repairs, test for leaks.

When using heat at or near a valve, wrap with a water-saturated rag to prevent overheating of vital parts.

EXPANSION VALVE TROUBLESHOOTING

TROUBLE	CAUSE
LOW SUCTION PRESSURE, HIGH SUPERHEAT Expansion valve limiting flow or adjustment too low.	Adjust and/or test expansion valve.
Inlet pressure too low from excessive vertical lift, undersize liquid line or excessive low condensing temperature. Resulting pressure difference across valve too small.	1. Increase head pressure. 2. If liquid line is too small, replace with proper size.
Gas in liquid line due to pressure drop in the line or insufficient refrigerant charge.	Locate cause of liquid line flash and correct by use of the following methods: (1) Add charge (2) Replace or clean filter dryer.
Inlet pressure too low from excessive vertical lift, undersize liquid line or excessive low condensing temperature. Resulting pressure difference across valve too small.	1. Increase head pressure. 2. If liquid line is too small, replace with proper size.
Gas in liquid line due to pressure drop in the line or insufficient refrigerant charge.	Locate cause of liquid line flash and correct by use of the following methods (1) Add charge (2) Replace or clean filter dryer (3) Check for proper line size.
Valve orifice too small.	Replace with proper valve.
Superheat adjustment too high.	Adjust superheat as outlined under Superheat Adjustment.
Power assembly failure or partial loss of charge.	Replace power assembly or replace valve.
Air filter screen clogged.	Clean or replace air filter screen.
King valve at liquid receiver too small or not fully opened. Hand valve stem failure or valve too small or not fully opened.	1. Discharge or suction service valve on compressor restricted or not fully opened. 2. Repair or replace faulty valve if it cannot be fully opened. 3. Replace any underside valve with one of correct size.
Plugged lines.	Clean, repair or replace lines.
Liquid line too small.	Install proper size liquid line.

MC-9 MAINTENANCE MANUAL

EXPANSION VALVE TROUBLESHOOTING (CONT'D)

Suction line too small.	Install proper size suction line.
LOW SUCTION PRESSURE, LOW SUPERHEAT Wrong compressor pulley size.	Install proper size pulley.
Uneven or inadequate evaporator loading due to poor air distribution or liquid flow.	Balance evaporator load distribution by providing correct air or liquid distribution.
HIGH SUCTION PRESSURE, HIGH SUPERHEAT Compressor discharge valve leaking.	Replace or repair valve.
HIGH SUCTION PRESSURE, LOW SUPERHEAT Valve superheat setting too low.	Adjust superheat as outlined under Superheat Adjustment.
Compressor discharge valves leaking.	Replace or repair discharge valve.
FLUCTUATING SUCTION PRESSURE Incorrect superheat adjustment.	Adjust superheat to 8-12°F (4-6°C).
FLUCTUATING DISCHARGE PRESSURE Insufficient charge.	Add charge to system.
HIGH DISCHARGE PRESSURE Air or non-condensable gases in condenser.	Purge and recharge system.
Overcharge of refrigerant.	Bleed to proper charge.
Condenser dirty.	Clean condenser.
Insufficient cooling air distribution over air cooled condenser.	Properly locate condenser to freely dispel hot discharge air.

LEAK TESTING LINES AND FITTINGS

All lines are copper tubing or Aeroquip No. 1540 hose. The copper lines have soldered joints and the large hose connections have a rubber O-ring seal.

LEAK TESTING - The most common method used is a halide torch consisting of an acetylene tank, a burner and a suction test hose.

WARNING: Do not inhale fumes from leak detector.

The flow of acetylene to the burner causes a suction in the test line. Any refrigerant gas present will be drawn through the hose and into the burner where it decomposes into free acids.

These acids come in contact with the hot copper reaction plate in the burner, causing color reaction in the flame. A small concentration is indicated by a green tint and a large concentration by an intense blue.

Do not confuse this change in color with the change caused by shutting off the air supply through the hose by holding the end too close to an object.

The procedure for testing is:

1. Adjust flame so the top of the cone is approximately level or within ½ inch (12.7 mm) above the plate.
2. Probe end of suction test tube around all joints, valves, etc. When a leak has been found at a soldered joint, that section of the system must be pumped down. Do not solder if pressure exists in the joint as pressure will force melted solder away from joint.

If the system is empty, it is more economical to put in just enough Freon to produce about 15 psi (103 kPa). The pressure can then be raised to about 150 psi (1,035 kPa) with dry nitrogen.

NOTE: This gas is put into the suction and discharge shut-off valves at the compressor. The receiver valves must also be opened. If no leaks are found, dump this mixture, evacuate the system and charge with refrigerant.

MC-9 MAINTENANCE MANUAL

A/C SYSTEM TROUBLESHOOTING

TROUBLE	REMEDY
LOW SUCTION PRESSURE AND FROSTING AT DRYER OUTLET Clogged filter-dryer element.	Clean filter element.
LOW OIL LEVEL	Check for oil leaks and for a leaking oil seal. Do not attempt to check oil level unless system has been stabilized at least 20 minutes.
EXCESSIVELY COLD SUCTION LINE Loss of contact between the expansion valve bulb and the suction line or sticking of the expansion valve.	Check for foreign matter and clean, repair or replace the valve.
EXCESSIVELY COLD SUCTION LINE AND NOISY COMPRESSOR	1. Check superheat adjustment. 2. Check remote bulb contact. 3. Check expansion valve for sticking.
COMPRESSOR SQUEAKS OR SQUEALS WHEN RUNNING	1. Check oil level. 2. Replace oil seal.
NOISY OR KNOCKING COMPRESSOR	1. Check for broken internal parts. 2. Overhaul if required.
COMPRESSOR VIBRATES	Check and tighten compressor mounting bolts.
EXCESSIVELY HOT CONDENSER AND HIGH DISCHARGE PRESSURE Air or non-condensable gas in system.	Purge system.
LOW REFRIGERANT LEVEL	Check for refrigerant leaks and add refrigerant if required.
SUCTION PRESSURE RISES FASTER THAN 5 POUNDS PER MINUTE AFTER SHUTDOWN	Check compressor valve for breakage or damage.
INSUFFICIENT COOLING	1. Check for refrigerant leaks. 2. Check condition of filter screens and motors.
INSUFFICIENT AIR FLOW Dirty or iced evaporator. Dirty air filter. Blowers inactive. Clogged ducts.	1. Check and clean evaporator, filters, ducts. 2. Recycle system.
FLOW OF REFRIGERANT THROUGH EXPANSION VALVE Dehydrator strainer is clogged. Remote bulb has lost charge. Expansion valve is defective.	1. Clean strainer. 2. Replace remote bulb and/or expansion valve.
EXPANSION VALVE HISSES BUBBLES IN MOISTURE AND LIQUID INDICATOR Gas in liquid line.	Add refrigerant.
LOSS OF CAPACITY Clogged dehydrator. Obstructed or defective expansion valve.	Check and clean as required.

A/C SYSTEM TROUBLESHOOTING (CONT'D)

SUPERHEAT TOO HIGH	1. Reset superheat adjustment. 2. Check for clogged external equalizer line, or dehydrator.
REDUCED AIR FLOW: (A) DIRTY OR CLOGGED AIR FILTER (B) C/H BLOWER INOPERATIVE (C) PLUGGED RETURN AIR DUCTS Dirty or iced evaporator coil.	1. Clean air filter screen. 2. Check return ducts for obstructions. 3. Check blower motor.
TOO FREQUENT STARTING AND STOPPING ON LOW PRESSURE CONTROL SWITCH Lack of refrigerant.	1. Check for leaks. 2. Recharge.
COMPRESSOR INTERMITTENTLY STARTS AND STOPS Intermittent contact in electrical control circuit. Compressor valves not in operating position.	1. Check control circuit components. 2. Check compressor valve operation.
FREQUENT STARTING AND STOPPING Low pressure switch controller differential set too close.	Check and adjust.
FREQUENT STARTING AND STOPPING High pressure switch controls differential too close.	Replace switch assembly.

AIR CONDITIONING COMPRESSOR

The Model 05G compressor is of the open reciprocating type, that is, of positive displacement. Compressor wear is minimized by splash lubrication and force feed lubrication, which is accomplished by a low-speed oil pump driven directly from the end of the compressor crankshaft. A mechanical seal prevents refrigerant leakage where the rotating shaft passes through the crankcase.

The compressor is equipped with flanges for connecting suction and discharge service valves. Sight glasses, installed on both sides of the crankcase, provide a means for checking oil level in the compressor crankcase. A drain plug facilitates draining of oil from the crankcase and an oil fill plug enables addition of oil when necessary. A bottom plate provides access through the bottom of the crankcase for maintenance.

The compressor uses reed type suction and discharge valves made of highest quality steel for long life. The valves operate against hardened integral seats in the valve.

The pistons move in a straight line, but alternately in divergent directions. The downstroke of the piston admits refrigerant gas through the suction valve, and then compresses this gas on the upstroke, thereby raising its temperature and pressure. The compressed gas is prevented from re-entering the cylinder on its next downstroke by the compressor discharge valve.

The 05G compressor uses pressure-operated unloaders. These unloaders are of the snap-action, cylinder head bypass type, using a piston-type control valve to control discharge gas flow (figure 16-22).

The pressure-operated unloaders are controlled by suction pressure and actuated by discharge pressure. Each

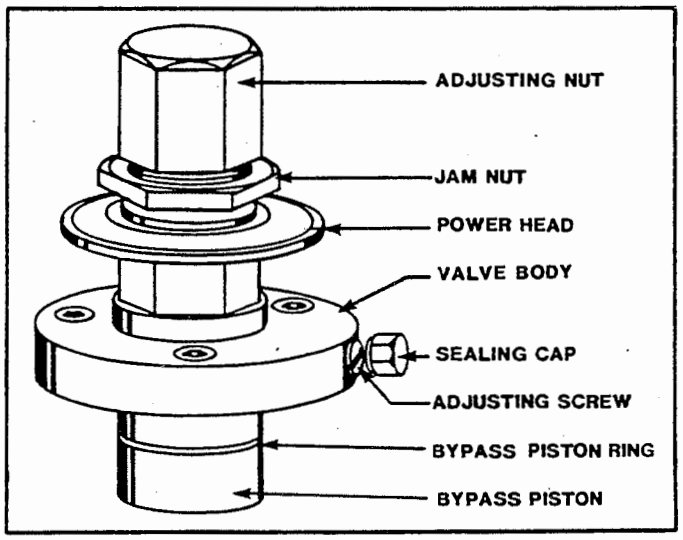


Figure 16-22: Compressor Capacity Control Loader

unloader valve controls two cylinders. On startup, controlled cylinders do not loadup until differential between suction and discharge pressure is 10 psi (69 kPa).

During loaded operation, when suction pressure is above the valve control point, the poppet valve will close. Discharge gas bleeds into the valve chamber, the pressure closes the bypass piston, and the cylinder bank loads up. Discharge gas pressure forces the check valve open, permitting gas to enter the discharge manifold.

During unloaded operation, when suction pressure drops below the valve control point, the poppet valve will open.

Discharge gas bleeds from behind the bypass piston to the suction manifold. The bypass piston opens, discharge gas is recirculated back to the suction manifold and the cylinder bank is unloaded. Reduction in discharge pressure causes the check valve to close, isolating the cylinder bank from the discharge manifold.

COMPRESSOR LUBRICATION SYSTEM

Force-feed lubrication of the compressor is accomplished by a low-speed oil pump driven directly from the compressor crankshaft. Refrigeration oil is drawn from the compressor crankcase through the oil filter screen and pick-up tube to the oil pump located in the bearing head assembly. The crankshaft is drilled to enable the pump to supply oil to the main bearings, connecting rod bearings, and the shaft seal. The lubricating oil is pumped, under pressure, through the lube system by a lobed-rotor type oil pump.

The oil flows to the pump end main bearings, connecting rod bearings and seal end main bearings, where the oil path is divided into two directions. The largest quantity flows to the oil relief valve, which regulates oil pressure at 15 to 18 psi (103.5-120.5 kPa) above suction pressure. When the oil pressure reaches 15 to 18 psi (103.5-120.5 kPa) above suction pressure, the relief valve spring is moved forward allowing oil to return to the crankcase. The remaining oil flows through an orifice and into the shaft seal cavity to provide shaft seal lubrication and cooling. This oil is then returned to the crankcase through an overflow passage (figure 16-23).

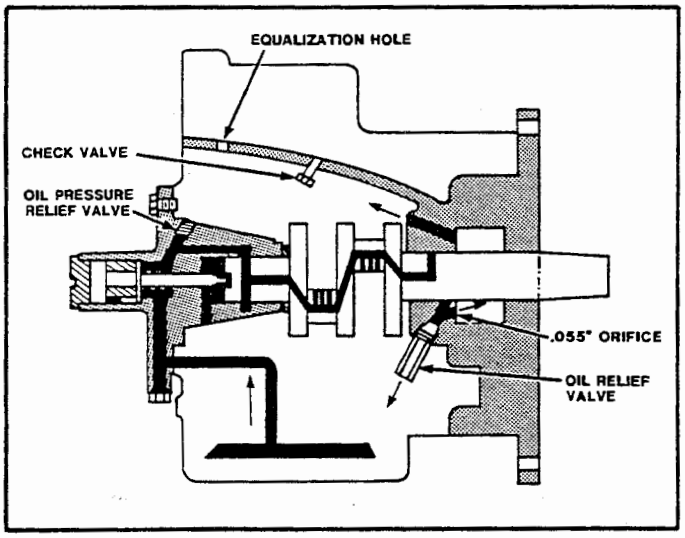


Figure 16-23: Compressor Lubrication Diagram

An additional oil pressure relief valve, built into the oil pump, is open at speeds above 400 rpm to relieve a portion of the oil pressure to the crankcase in order to maintain oil pressure below an acceptable maximum. At low speeds, the valve is closed to ensure adequate oil pressure at 400 rpm. At speeds above 1,900 rpm, the oil pressure will be 25 to 30 psi (172.5-207 kPa) above suction pressure.

The oil pressure equalization system consists of two oil return check valves and a ⅛-inch pressure equalization port between the suction manifold and crankcase. Under normal conditions, check valves are open and allow for oil return to the crankcase. Under flooded start conditions, pressure rises in the crankcase and closes the check valves, preventing excess oil loss. The equalization port allows for release of excessive pressure, that has built up in the crankcase, to the suction manifold; this ensures that the oil loss is kept to a minimum.

SUCTION AND DISCHARGE SERVICE VALVES

The suction and discharge service valves on the compressor are equipped with mating flanges for connecting to flanges on the compressor. These valves are provided with a double seat and a gauge connection, which enables servicing of the compressor and refrigerant lines (figure 16-24).

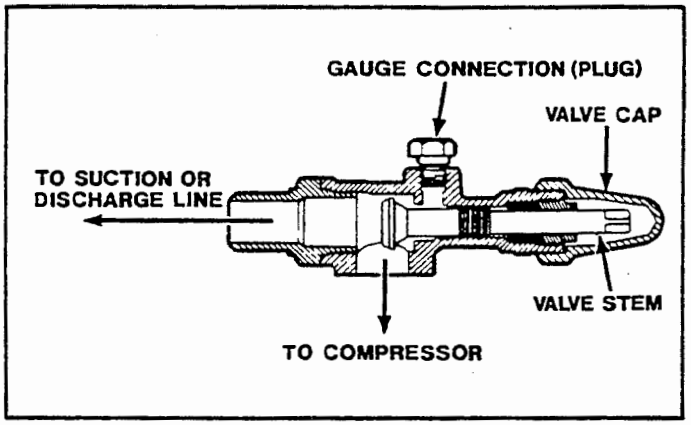


Figure 16-24: Suction/Discharge Valve

Turning the valve stem clockwise (all the way forward) frontseats the valve, closing off the suction and discharge lines and opening up the gauge connection to the compressor. Turning the valve stem counterclockwise (all the way out) backseats the valve, opening the suction or discharge line to the compressor and closing off the gauge connection.

With the valve stem midway between frontseated and backseated positions, suction or discharge line is open to both the compressor and the gauge connection.

For example, when connecting manifold gauge to measure suction or discharge pressure, ensure valve stem is fully backseated. Then, to measure suction or discharge pressure partially frontseat (about two turns) the valve stem.

SETTING UNLOADERS (Engine Side) - Before setting unloaders, fully backseat the suction service valve and install the low pressure service gauge into the suction service valve.

1. Remove the cap from the differential adjustment screw and turn the screw out until it is approximately 2 turns from backstop.
2. Turn the unloader adjusting nut as far back as possible, without removing it.
3. With the engine running and A/C on, partially frontseat the suction service valve until the pressure gauge reads 30 psi (207 kPa).

4. Turn the adjusting nut until the needle on the service gauge "jumps" to 36 psi (248 kPa).

5. If the unloader loads above or below 36 psi (248 kPa), adjust the differential screw until the desired setting is reached.

6. Once the adjustments have been made, tighten the jam nut against the adjusting nut, ensuring the adjusting nut does not move. Replace the differential adjustment screw cap.

The procedure for setting the curb side unloader is identical except for the following substitution for steps 3 and 4.

Partially frontseat the suction service valve until the pressure in the service gauge reads 24 psi (165.6 kPa). Turn in the adjusting nut until the needle on the service gauge "jumps" to 30 psi (207 kPa).

COMPRESSOR OIL LEVEL CHECK - Perform this produre:

1. Operate coach engine at fast idle with A/C switch ON for at least 20 minutes. Shut engine off.

2. Open rear and right side engine compartment doors. Sight gauges are located on both sides of compressor crankcase. Oil level is correct when engine side sight gauge is full and curb side sight gauge is empty.

3. If below correct oil level, check freon level before adding oil.

4. If adding oil is required, proceed with the following.

ADDING OIL:

1. Backseat suction service valve and install low pressure service gauge hose into suction service valve fitting. Frontseat both sides of service gauge. Attach hose to middle port of service gauge manifold and completely submerge the other end in oil supply.

2. Disconnect liquid line solenoid wire, stud 11 in A/C junction box.

3. Connect jumper wire between horizontal studs 1 and 2 in remote control box.

NOTE: The preceding wiring changes will allow the clutch to remain engaged after pressure drops below 15 psi (103.5 kPa). It is necessary for the compressor to pump down into a vacuum to add oil in this manner.

4. Frontseat suction service valve and crack open the low pressure service gauge to purge the oil supply line. After purging line, frontseat service gauge.

5. Start engine and actuate air conditioning system.

6. When pressure in service gauge reads a vacuum, crack open the service gauge to allow oil to be drawn into compressor. When desired amount of oil is added, frontseat gauge.

7. Completely backseat suction service valve, disconnect jumper in remote control box and connect liquid line solenoid in A/C junction box.

8. Run A/C system 15-20 minutes and check oil level.

9. If more oil is needed, repeat procedure.

A pressurized oil pump that overcomes compressor pressure and forces oil into the crankcase may also be used. For further details, consult service department.

HI & LO PRESSURE SWITCH TESTS AND UNLOADER CHECK

HI PRESSURE SWITCH TEST:

1. Connect high pressure service gauge to discharge service valve test fitting; open or cover the condenser door.

2. With engine operating at fast idle, high pressure switch should open at 300 ± 10 psi (2,070 ± 69 kPa) and cause compressor clutch to disengage.

NOTE: Observe front plate of clutch. When clutch is engaged, pulley and front plate rotate together. When clutch is disengaged pulley will rotate, but front plate will not.

3. Close, or uncover the condenser door. Observe pressure gauge and front plate of clutch at 190 ± 10 psi (1,310 ± 69 kPa) pressure switch should close and clutch should engage.

LO PRESSURE SWITCH TEST:

1. Connect low pressure service gauge to suction service valve test fitting.

2. Partially frontseat service valve until suction pressure reads 5 ± 3 psi (34.5 ± 20.7 kPa). Low pressure switch should open, clutch should disengage.

3. Slowly backseat suction service valve. Observe service gauge and front plate of clutch. When pressure reads 20 ± 3 psi (137.9 ± 20.7 kPa) switch should close and clutch should engage.

CHECK UNLOADER OPERATION:

1. Operate engine at fast idle with A/C system ON, condenser door closed, and service gauges installed in suction and discharge service valves.

2. Partially frontseat suction service valve and observe the service gauges to determine pressure at which unloaders operate.

The engine side bank should load at 36 psi (248 kPa) and unload at 30 psi (207 kPa). The curb side bank should load at 30 psi (207 kPa) and unload at 24 psi (165.6 kPa). Load and unload pressures are adjusted at the cylinder head control set point adjust nuts (figure 16-22).

COMPRESSOR REMOVAL

1. If the compressor is inoperative, frontseat the suction and discharge service valves to trap the refrigerant in the system. If the compressor will operate, pump down the air conditioning system; then, frontseat the suction and discharge service valves.

2. Slowly loosen plug in gauge connection on suction and discharge service valves and bleed refrigerant pressure to atmosphere.

3. Loosen the capscrews that mount the suction and discharge service valves, and tap the valves with a hammer to free them from the mounting flanges. Remove capscrews and service valves, but do not remove hoses from valves.

4. Disconnect electrical leads to compressor.

5. To remove the compressor drive belts, exhaust the air from the belt tensioning cylinder by opening the valve

located above the compressor pulley. This will loosen the belts enough to facilitate removal.

6. Remove the four nuts that mount the compressor to the mounting bracket and remove the compressor from the coach.

CAUTION: The compressor weighs approximately 145 lbs. (65 kg). Exercise extreme caution during removal procedure. Use adequate sling and hoist.

REPLACEMENT AND INSTALLATION

Replacement compressors are normally furnished without suction and discharge service valves. The service valves are normally retained on the unit to isolate the refrigerant lines during compressor replacement. Blankoff pads are usually installed on the service valve flanges. These pads must be removed prior to installing the compressor. If the faulty compressor is to be returned for overhaul or repair, install the pads on the compressor for sealing purposes during shipment.

CAUTION: Do not backseat (open) suction and discharge service valves until the compressor has been leak tested and evacuated.

1. Install compressor in coach; reverse removal procedure, above.
2. Install new locknuts on compressor mounting bolts and new gaskets on suction and discharge service valves.
3. Check oil level in oil level sight glass. Oil level should be between bottom ⅛ and ½ of sight glass. If necessary, add or remove oil.
4. Leak test, evacuate, and dehydrate the compressor.
5. Fully backseat suction and discharge service valves.
6. Operate the compressor and check for leaks and noncondensibles in the refrigerant system.
7. Check refrigerant level.
8. Recheck compressor oil level.
9. Check operation of capacity control unloaders.

DISASSEMBLY

Prior to disassembly of the compressor, oil must first be drained from the crankcase. Refer to figure 16-25.

1. Remove the oil fill plug to vent the crankcase. Loosen the drain plug in the bottom plate and allow the oil to drain completely.
2. If dismantled parts are to be left overnight or longer, dip them in clean compressor oil and wrap them in oil soaked rags to prevent rusting.

NOTE: If a faulty part in the compressor is to be replaced, it may be necessary to remove other parts first. Therefore, the disassembly instructions that follow are arranged in the order for complete disassembly.

WARNING: Do not unscrew capscrews all the way before breaking seal. Entrapped pressure could result in injury.

3. Loosen cylinder head capscrews. If the head is stuck, tap it lightly with a wooden or lead mallet to free it.
4. Remove cylinder head. Be careful not to drop the head or damage the gasket sealing surface (figure 16-26).



Figure 16-26: Removing Cylinder Head

5. Remove cylinder head capscrews and gasket from the head.
6. Remove the discharge valve capscrews, lock washers, stops, and valves (figure 16-27).

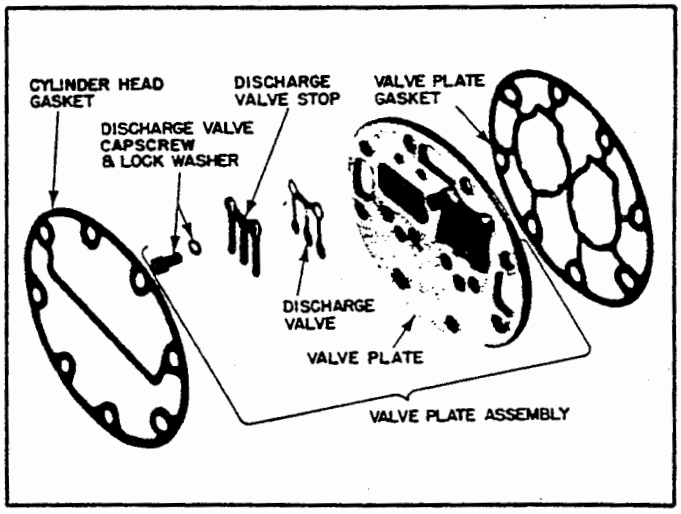
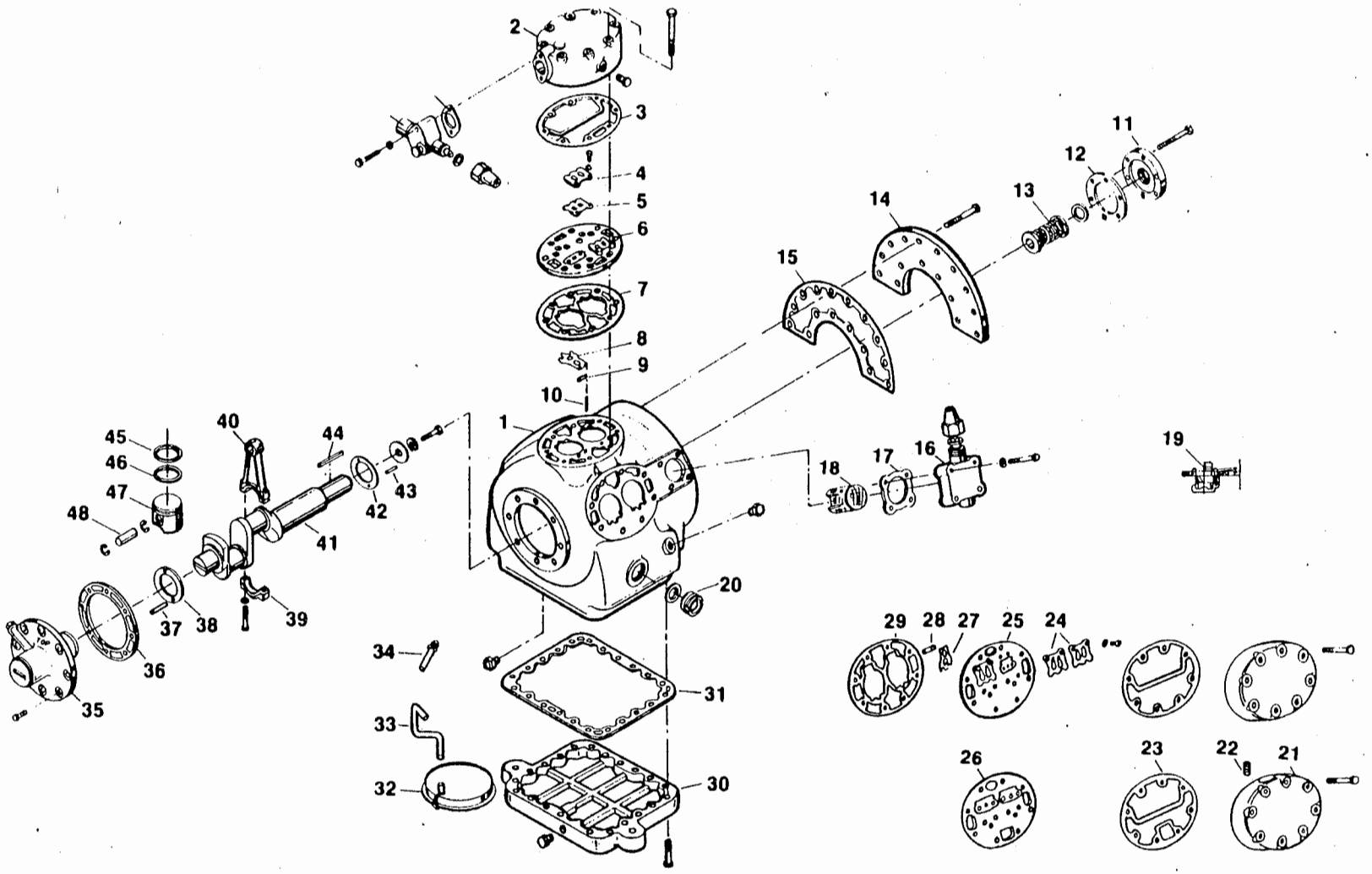


Figure 16-27: Discharge Valve Assembly

7. Free the valve plates from the cylinder deck by using the discharge valve capscrews, without washers, as jackscrews through the outermost tapped holes in the valve



1 Crankcase
2 Cylinder Head, Center Bank
3 Gasket
4 Stop, Discharge Valve
5 Discharge Valve
6 Valve Plate
7 Gasket
8 Suction Valve
9 Spring
10 Dowel
11 Seal Cover, Shaft
12 Gasket
13 Seal Assembly, Shaft
14 Flange
15 Gasket
16 Suction Valve
17 Gasket
18 Strainer
19 Unloader Check Valve
20 Sight Glass
21 Cylinder Head
22 Strainer
23 Gasket
24 Stop, Discharge Valve
25 Valve Plate
26 Valve Plate
27 Suction Valve
28 Spring
29 Gasket
30 Bottom Plate
31 Gasket
32 Oil Filter Screen Assembly
33 Oil Suction Tube
34 Oil Relief Valve
35 Oil Pump Assembly
36 Gasket
37 Pin
38 Thrust Washer
39 Rod End Cap
40 Connecting Rod
41 Crankshaft
42 Thrust Washer
43 Spirol Pin
44 Key
45 Ring, Compression
46 Ring, Oil
47 Piston
48 Pin, Piston
49 Discharge Shut-off Valve
50 Gasket

Figure 16-25: Compressor Components

plate after the valve stops and valves have been removed. Remove the valve plate gasket (figure 16-28).



Figure 16-28: Valve Plate Removal

8. Discard valves and gaskets. Use only new valves and gaskets when reassembling cylinder head and valve plate assemblies.

9. Turn the compressor over, bottom side up, and remove the bottom plate (figure 16-29). Scrape off all gasket material.

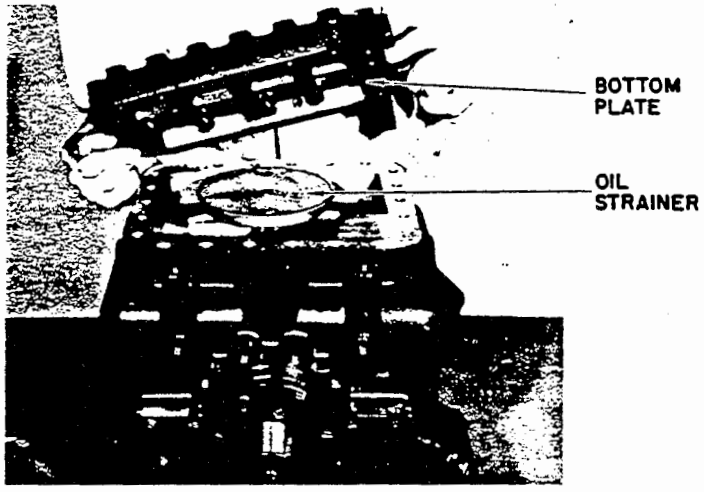


Figure 16-29: Bottom Plate Removal

10. Remove the oil strainer.

11. Matchmark each connecting rod cap and connecting rod for correct reassembly.

12. Remove the capscrews, flat washers and connecting rod caps (figure 16-30).

NOTE: The capscrews and flat washers should be discarded and new epoxy encapsulated capscrews and flat washers installed during compressor reassembly.

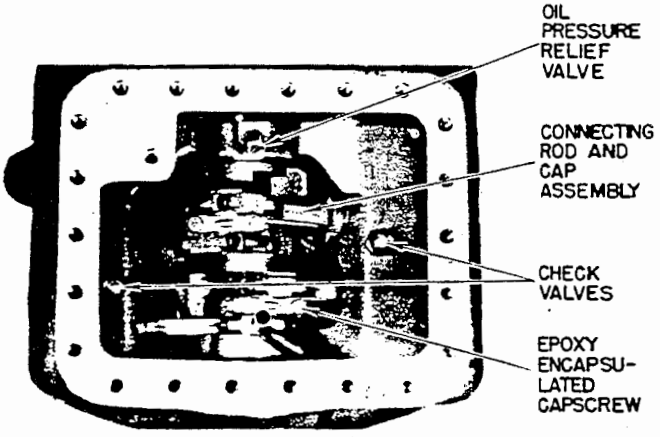


Figure 16-30: Compressor Crankcase Parts

13. Push the piston rods down so that the piston rings extend below the cylinders (figure 16-31). Remove and discard piston rings.

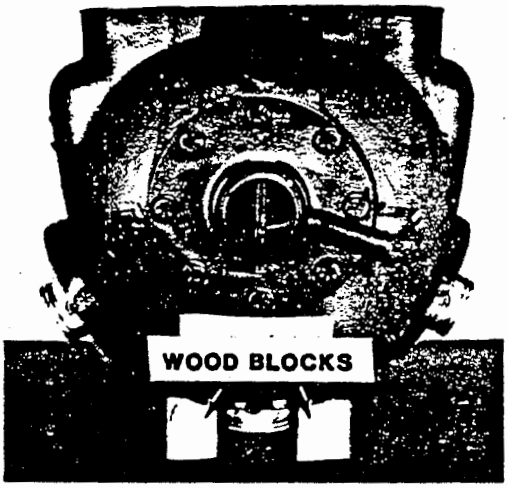


Figure 16-31: Piston Ring Removal

14. Remove eight capscrews and remove oil pump bearing head assembly, gasket and thrust washer (figure 16-32). Disassembly and cleaning of the pump and bearing head assembly will be accomplished during inspection and before reassembly.

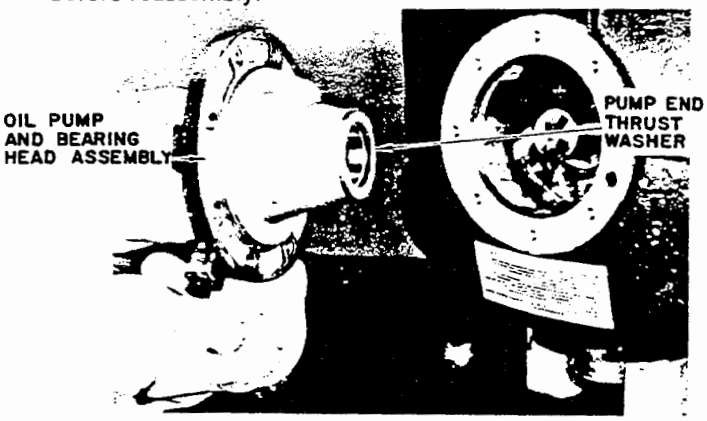


Figure 16-32: Removing Oil Pump Assembly

15. Remove six capscrews and remove shaft seal cover and carbon washer (figure 16-33).

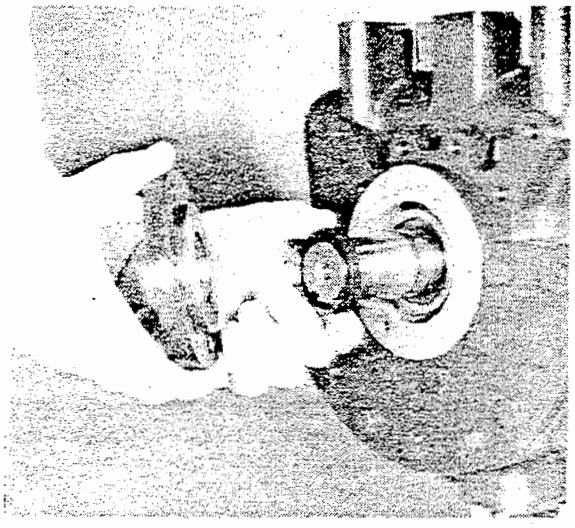


Figure 16-33: Removing Shaft Seal Cover and Carbon Washer

16. Tap seal end of crankshaft to loosen seal grip on shaft. Using two long screwdrivers, pry out the shaft seal (figure 16-34).

CAUTION: Do not allow crankshaft to drop on connecting rods inside the crankcase when removing the crankshaft.

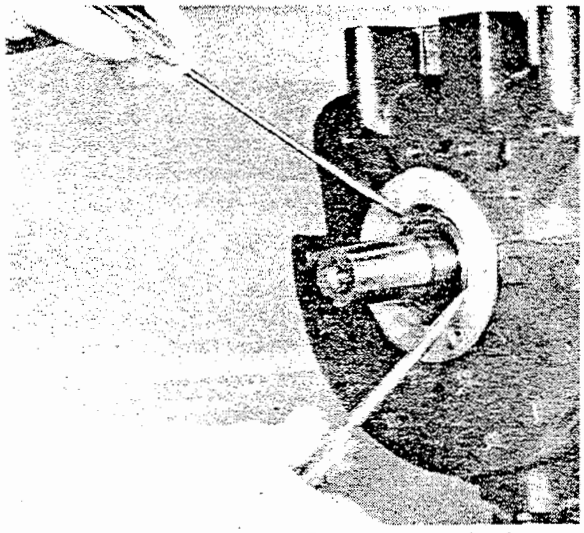


Figure 16-34: Carefully Pry Out Shaft Seal

17. Push piston rod assemblies out of the way and remove the crankshaft and seal end thrust washer.

18. Remove and check operation of the oil return check valves. The check valves are free-floating and can easily be checked visually.

19. Remove and check oil pressure relief valve. The oil pressure relief valve is a spring-loaded device which can be checked by using a small piece of stiff wire to ensure that the spring mechanism can be depressed.

20. Remove the piston rod assemblies.

21. Remove the suction strainer. Clean the strainer screen with solvent. Inspect the strainer; if damaged, replace it.

OIL PUMP AND BEARING HEAD - If it was determined that the oil pump was not operating properly, the entire oil pump and bearing head assembly must be replaced. Replacement parts for the pump are not available.

If the oil pump was operating properly, disassemble the pump, clean all parts, and reassemble the pump as follows (steps 22-32).

22. Remove pump cover and O-ring (figure 16-35).

23. Remove pin by holding eccentric in, tipping top of pin slightly outward, and turning pump bottom side up; pin should fall out.

24. The remainder of the pump components can now be removed by pushing out the drive segment from the crankshaft end of the bearing head.

25. Remove the relief valve assembly by removing the retainer pin.

26. Clean all parts; coat all moving parts with compressor oil before proceeding with reassembly.

27. Insert drive segment and five-lobed rotor, ensuring that the pins on the rotor are inserted into the appropriate holes in the drive segment drive wheel.

28. Reinstall the four-lobed rotor inside the five-lobed rotor, ensuring that the end with the counterbore is installed toward the drive segment.

29. Reinstall the eccentric.

30. Reinstall the pin in the shortest of the two grooves inside the bearing head.

31. Reinstall the O-ring and pump cover.

32. Reinstall the relief valve assembly.

PISTONS, PIN, AND CONNECTING RODS - Piston and pin, and connecting rod and rod cap are matched sets and must not be interchanged. If either the piston or piston pin is to be replaced, you must replace both of them. Likewise, if a connecting rod or rod cap must be replaced, both must be replaced.

33. Matchmark and disassemble pistons, pins, connecting rods, and caps.

34. Check wear dimensions of disassembled parts to determine if they are worn beyond limits. Refer to figure 16-25. If parts are worn beyond limits, replace them in matched sets as specified above.

35. Coat piston pins with compressor oil and reassemble piston pins, and connecting rods in matched sets.

INSPECTION

1. Clean all parts with an approved solvent such as methyl ethyl ketone (MEK). Use a stiff bristle brush to remove dirt from grooves and crevices.

2. Inspect all parts for wear and overall condition. Replace any defective or excessively worn parts.

3. Inspect suction and discharge valve seats on both sides of valve plate.

4. Inspect operation of unloader bypass piston.

5. Take inventory of all parts to ensure they are complete.

After cleaning, coat all moving parts with compressor oil before reassembly.

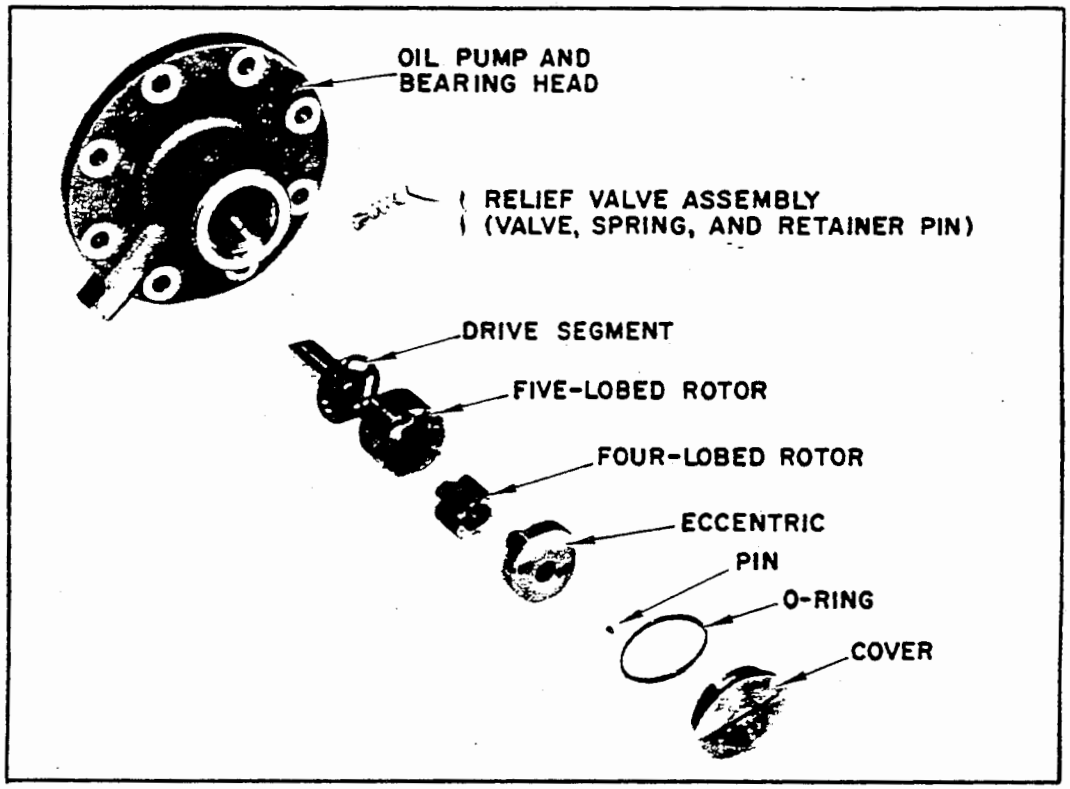


Figure 16-35: Oil Pump Parts

6. Use only new gaskets during reassembly. Ensure all metal gaskets (includes cylinder head, valve plate, and unloader by bypass plug gaskets) are installed dry. All fiber gaskets should be finger wiped with compressor oil before installing.

REASSEMBLY

1. Prior to installing new piston rings, it is necessary to break the hard glazed surface of the cylinder in order to reduce the wearing-in period of the new rings. Break the glaze by rehoning lightly in an up-and-down rotating motion. Clean thoroughly after breaking glaze.

2. The gap between the ends of the piston rings can be checked with a feeler gauge by inserting the ring into the piston bore about one inch below the top of the bore. Align the ring in the bore by pushing it slightly with a piston. The maximum and minimum allowable ring gaps are 0.013 and 0.005 inches (0.33 and 0.127 mm).

3. Install the piston and rod assemblies (figure 16-36) up through the bottom of the crankcase and into the cylinders. Allow pistons to extend beyond the top of the cylinder to enable installation of piston rings. Pistons should be installed so that the chamfer on the connecting rod faces toward the crankshaft journals. Center rods on each crankshaft throw may be installed in either direction (figure 16-37).

NOTE: Do not push pistons back into cylinder until after crankshaft is installed.

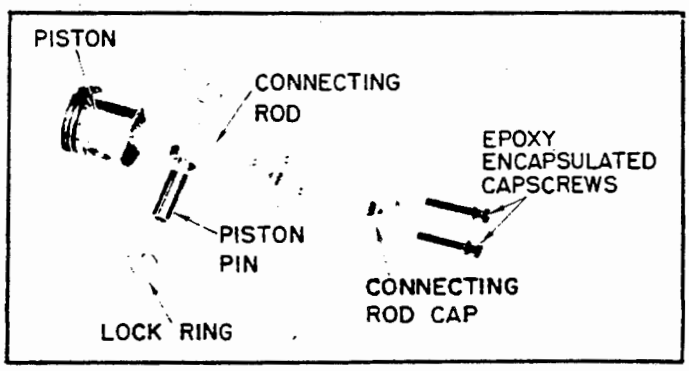
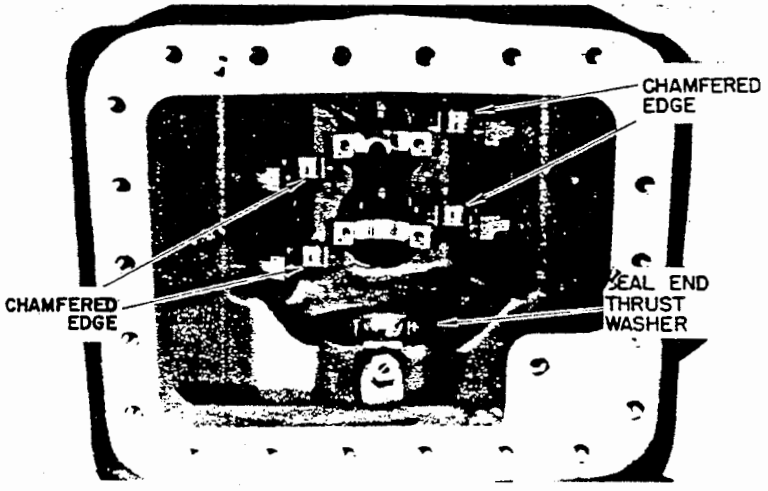


Figure 16-36: Piston and Connecting Rod Assembly



4. On each piston, install the oil ring first, in the second groove, and the compression ring next, in the first groove nearest the piston top. The oil ring is notched and must be installed with the notch on the outside circumference and on the bottom. The compression ring is tapered on the inside circumference (figure 16-38). Install this ring with the taper on the top of the ring facing toward the valve plate.

NOTE: When installing the rings, stagger the ring ends so that the gaps are not aligned. The ring grooves must be smooth so that the ring will not bind when compressed. Ensure that side clearance is 0.001 to 0.002 inch (0.0254 to 0.0508 mm) between the ring and the piston.

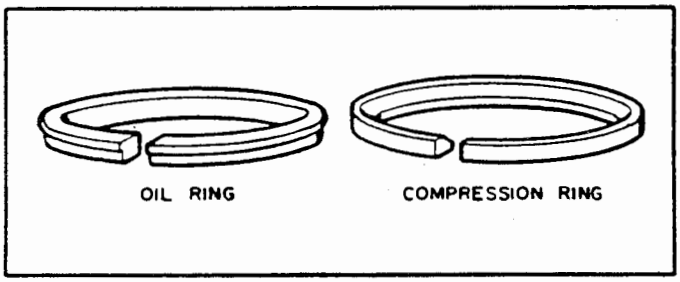


Figure 16-38: Piston Rings

5. Inspect the two brass thrust washers and replace if worn or scored.

6. Install the seal end thrust washer on the two dowel pins in place in the crankcase. See figure 16-25, Compressor Parts.

CAUTION: Exercise care to make sure the crankshaft does not drop down onto the connecting rods when installing the crankshaft in the crankcase.

7. Push the pistons out of the way and install the crankshaft.

8. Install the pump and thrust washer on the two dowel pins located on the bearing head (figure 16-39).

CAUTION: Ensure that thrust washer does not fall off dowel pins while installing oil pump.

9. Install the bearing head assembly on the compressor crankshaft with a new gasket. Carefully push oil pump on by hand ensuring that the thrust washer remains on the dowel pins. The tang on the end of the drive segment engages the slot in the crankshaft, and the oil inlet port on the pump is aligned with the oil pickup tube in the crankcase. The pump should mount flush with the crankcase and should be oriented as shown in figure 16-39.

10. Align the new oil pump gasket and install the eight capscrews in the mounting flange.

11. Using a ring compressor, squeeze the rings sufficiently to allow piston to be pushed into the cylinder.

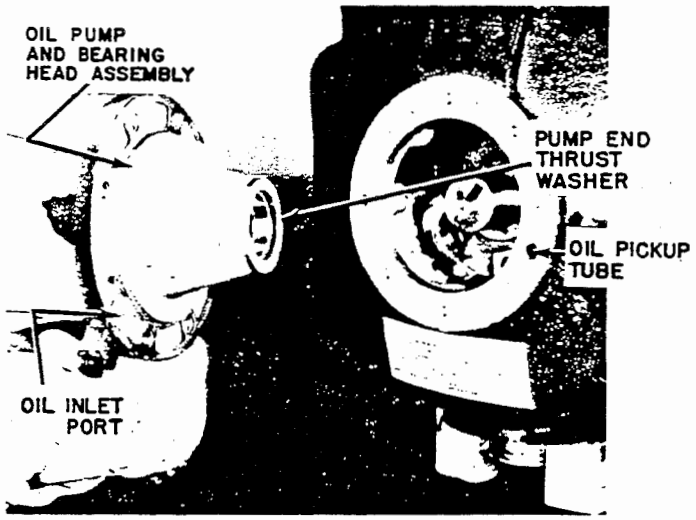


Figure 16-39: Installing Oil Pump

Ensure that ring ends are staggered so that gaps are not aligned, and lightly tap piston down into the cylinder (figure 16-40).

NOTE: The ring compressor can be easily fabricated from a piece of sheet metal.

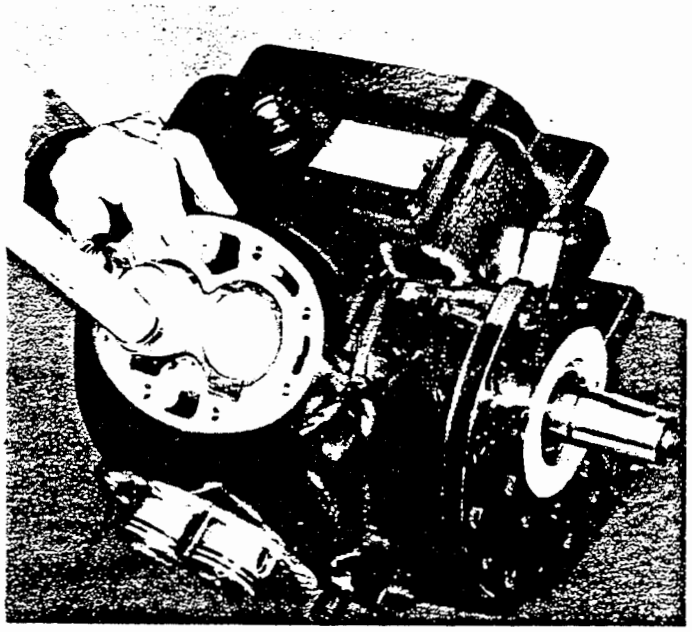


Figure 16-40: Tapping Piston Into Cylinder

12. Check matchmarks and install connecting rod caps on connecting rods using new epoxy encapsulated capscrews and flat washers. Reuse of the old capscrews is not recommended. Ensure that the caps are installed on the dowel pins.

13. Tighten capscrews to 8-10 lbs.-ft. (10.8-13.5 Nm) torque. Ensure freedom of movement of crankshaft after capscrews are tightened on each rod cap.

14. Check operation and reinstall check valves and relief valve. The check valves are free-floating devices and can easily be checked visually. The relief valve is a spring-

loaded device which can be checked by using a small piece of stiff wire to ensure that the spring mechanism can be depressed.

15. Clean and reinstall the oil strainer

16. Using a new gasket, install the bottom cover plate. Tighten cove capscrews, in a diagonal pattern, to 25-30 lb.-ft. (24-40.6 Nm) torque.

CAUTION: Never reinstall a used seal assembly or gasket. A new carbon washer should never be installed in a used cover plate. When installing the seal assembly, use care not to damage carbon washer or seal seat. If the new carbon washer is damaged during installation, replace it with a new one.

17. Remove new carbon washer from new seal assembly (figure 16-41). Lubricate shaft and neoprene seal bellows where it contacts the shaft.

CAUTION: Handle carbon washer by touching only the outside edge.

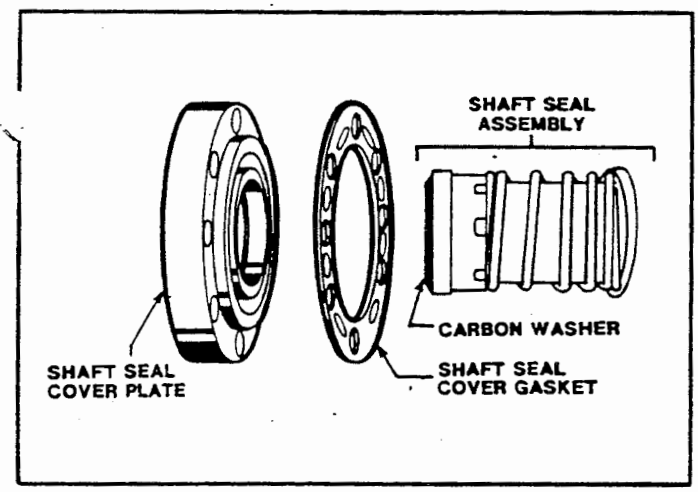


Figure 16-41: Shaft Seal Assembly

18. Slide seal assembly onto shaft until neoprene bellows starts to grip the shaft (figure 16-42).

19. Install the old carbon washer in the new seal seat. Install two capscrews in opposite sides of the old cover plate. Draw up capscrews evenly to properly position new seal assembly against shoulder on shaft.

20. Remove capscrews and old carbon washer and cover plate.

21. Lubricate new carbon washer and carbon washer seal seat with refrigerant oil. Install new carbon washer on the seat. Ensure that notches in carbon washer are aligned th two small knurls inside the seal seat.

22. Install the new cover plate and gasket. Draw capscrews down evenly to prevent damage to carbon washer.

CAUTION: Install only new valves and gaskets, and do not interchange valves.

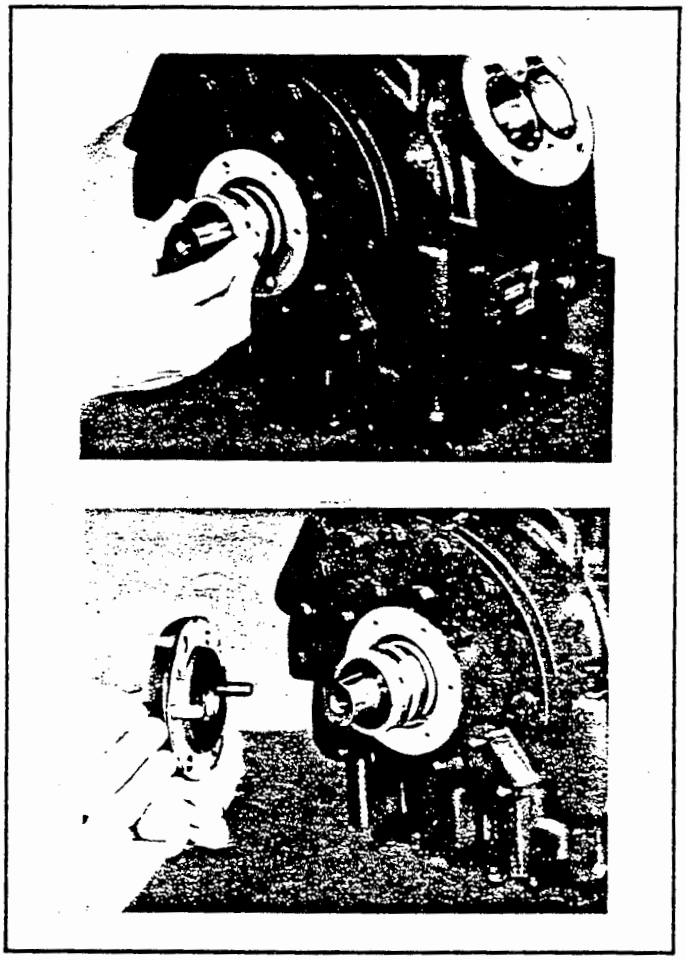


Figure 16-42: Installing Shaft Seal Assembly

23. Install suction valve, positioning springs on dowel pins. Assemble positioning springs with spring end bearing against cylinder deck. The spring will bow outward in the middle (figure 16-43).

24. Place suction valves on dowel pins, over the positioning springs.

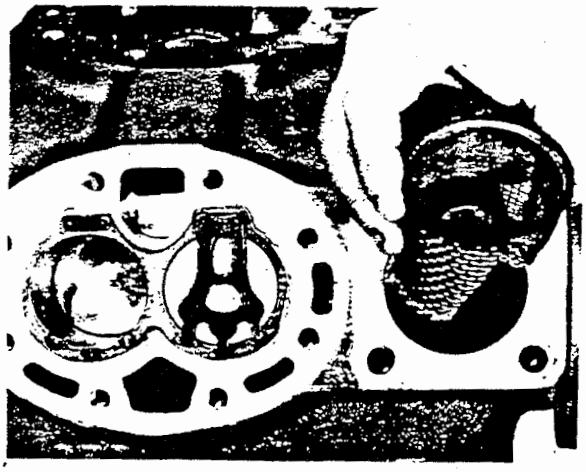


Figure 16-43: Suction Valve Installed Over Cylinders

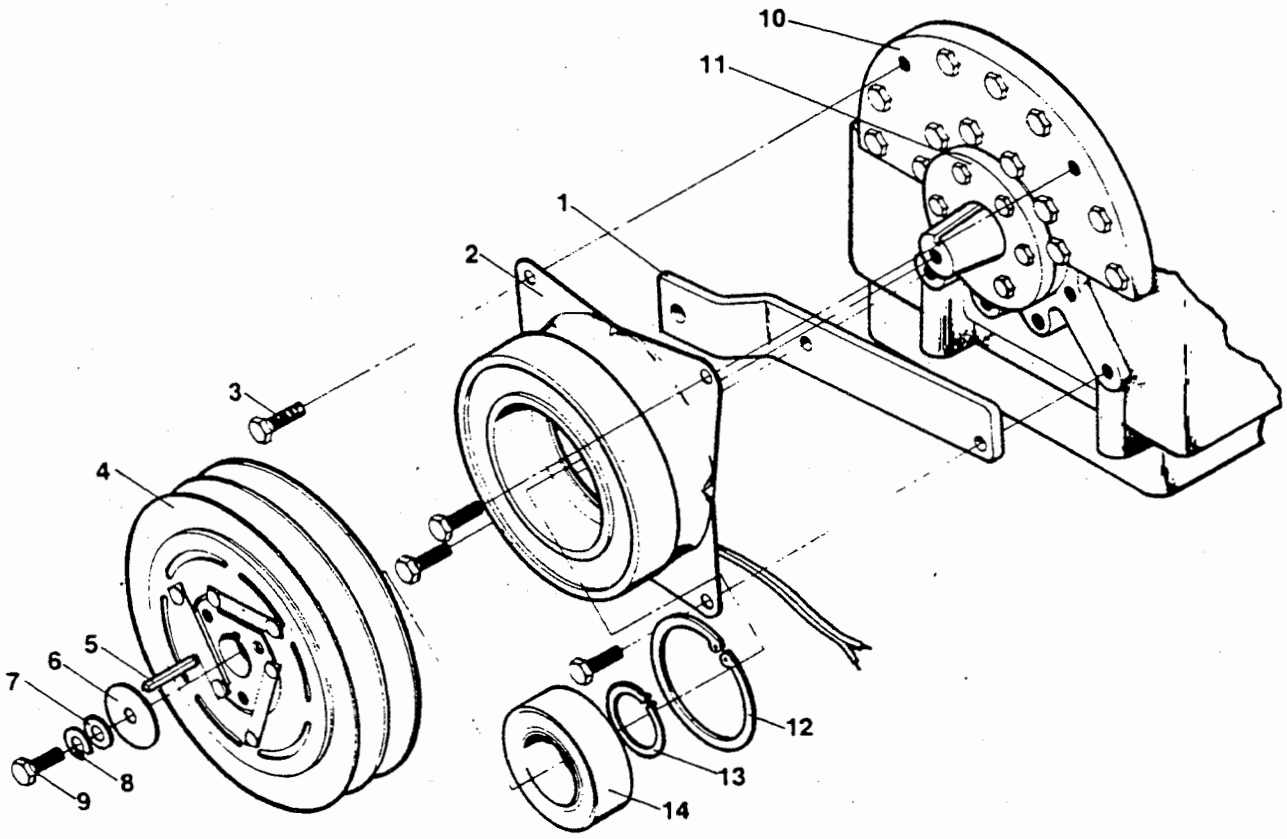
pressor crankshaft, the compressor begins operating when the pulley transmits its rotation to the armature.

The compressor will operate as long as the clutch field coil remains energized - armature and rotor magnetically coupled. When the field coil is de-energized, the armature is pulled back, out of contact with the rotor (by spring tabs) and the armature (and compressor shaft) ceases rotation.

NOTE: A housing-mounted clutch has 6 mounting nuts on the armature; a shaft-mounted clutch does not have these 6 nuts.

MAINTENANCE - If the compressor clutch is mounted on the compressor shaft (figure 16-47), the clutch bearing has no provision for lubrication. Maintenance of this unit is limited to inspecting the clutch for wear, replacing the clutch as required, and checking the resistance of the coil winding. For shaft-mounted compressor clutch, perform the following procedure; if clutch is housing-mounted, skip this procedure and perform the subsequent maintenance procedure (Housing-Mounted Clutch Maintenance).

1. For the shaft-mounted clutch, clean all dirt and grease from the clutch armature plate. Take care not to allow the foreign material to be displaced into the armature slots and between clutch faces.
2. With compressed air, blow all dirt out from clutch facing area.



1. A/C Belt Tension Cylinder Mtg. Brkt.
2. Coil
3. Capscrew, Mtg. Coil
4. Rotor and Armature Assembly
5. Key
6. Large Flat Washer
7. Small Flat Washer
8. Lock Washer
9. Capscrew, Mtg. Pulley
10. A/C Compressor Half Flange
11. Seal Cover Plate
12. Bearing Retaining Ring (Outer)
13. Bearing Retaining Ring (Inner)
14. Bearing

Figure 16-47: Shaft-Mounted Compressor Clutch

25. Place valve plate and new valve plate gasket on cylinder deck, ensuring that the valve plate is properly positioned on the four dowel pins (the top head has five dowel pins)(figure 16-44).

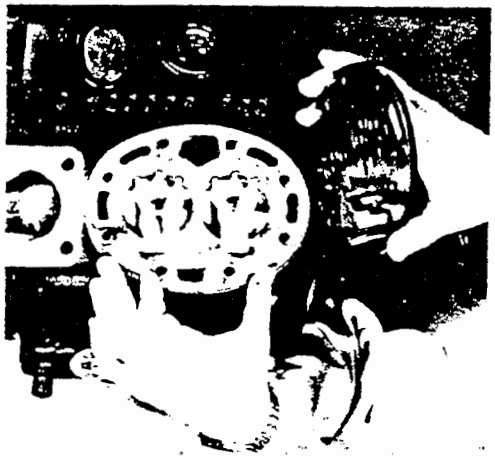


Figure 16-44: Installing Valve Plate and Gasket

26. Using a small screwdriver, flex the suction valves to ensure that the valve tips are not being held by the valve plate gasket (figure 16-45).

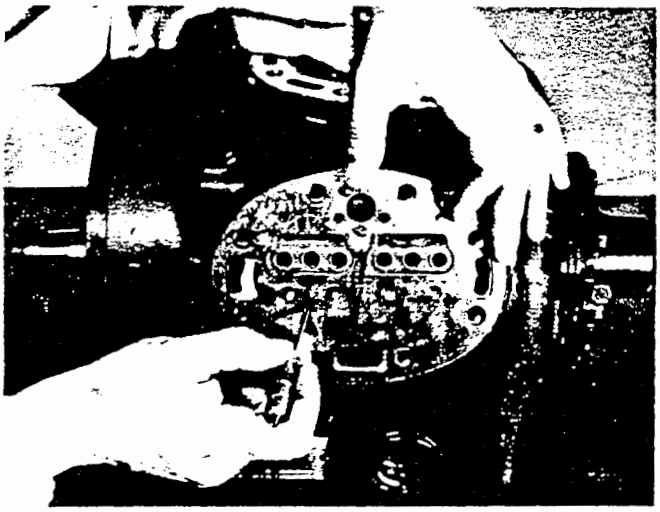


Figure 16-45: Flexing Suction Valve

27. Install discharge valve and discharge valve stop with capscrews and lock washers (figure 16-46). Tighten capscrews to 16-20 lb.-ft. (21.7-27 Nm) torque.

NOTE: Capacity control unloaders are in place in the right and left cylinder heads. Refer to Capacity Control Unloaders, in this section, for instructions on their removal and installation if they are to be serviced.

28. The center tank has a flange connection for the discharge service valve. Install center cylinder head and new cylinder headgasket with capscrews, ensuring that the

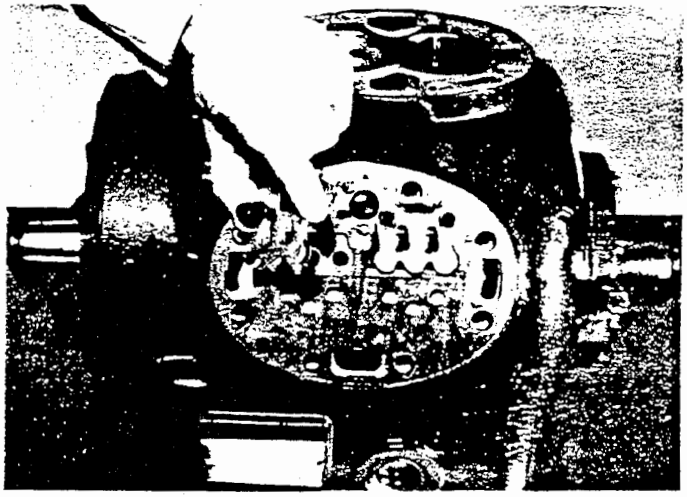


Figure 16-46: Installing Discharge Valve and Stop

gasket and cylinder head are properly positioned on the valve plate.

29. Tighten the capscrews, in a diagonal pattern, 30-35 lb.-ft. (40.6-47 Nm) torque. Repeat steps 23-29 for the other two cylinder banks.

NOTE: Suction strainer has been preformed to fit into suction cavity.

30. Remove and clean the suction strainer (figure 16-43). Check it for damage. If it is damaged, replace it. Reinstall the suction strainer and valve blank-off pad using a new gasket.

31. Install compressor according to previous instructions. Allow compressor to operate 4 to 5 hours before checking seal assembly for leakage.

CAPACITY CONTROL UNLOADERS

1. Remove the three socket-head capscrews holding the flange cover to the cylinder head.
2. Remove the unloader from the cylinder head.
3. Scrape all gasket material from cylinder head and flange cover.
4. Thoroughly clean unloaders in solvent (MEK) and inspect for evidence of wear, pitting, spring weakness, etc. Replace unloaders determined to be inoperative or defective.
5. Install new gasket and unloaders. Tighten unloader mounting nut to 12-16 lb.-ft. (16-22 Nm) torque.
6. Install the three socket-head capscrews into the unloader flange cover and cylinder head.

COMPRESSOR CLUTCH

The air conditioning compressor clutch is an electrically operated, friction-faced clutch. When the air conditioning system is off, the clutch rotor (pulley) is free-wheeling, being driven by the coach engine by way of the two drive belts. When the A/C system temperature sensor actuates the system, the compressor clutch field coil is energized. The magnetic field produced by the coil attracts the clutch armature, engaging its face with the rotating face of the rotor. Since the armature is coupled directly to the com-

3. Using a depth micrometer, measure and record the distance from the back of the armature to the face of the rotor. See figure 16-48.

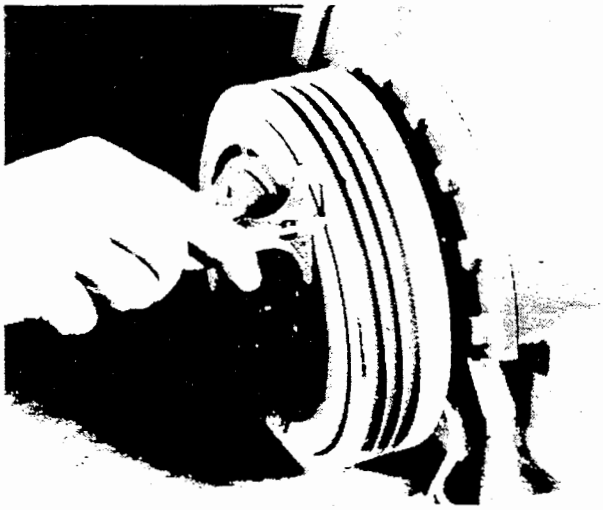


Figure 16-48: Armature-to-Rotor (Air Gap) Measurement

4. Disconnect the clutch coil electrical lead. Ground one connector terminal and connect 24 VDC to the other terminal to energize the coil.

5. Repeat step 3 for the measured distance when the armature and rotor faces are engaged.

6. De-energize the coil and determine the difference between the two measurements. If the difference exceeds .110" (2.794 mm), the clutch rotor and armature require replacement. Proceed to step 7. If the distance is .110" (2.794 mm) or less, clutch wear indicates replacement is not necessary.

7. To remove the shaft-mounted clutch, first open the two-way manual valve to vent air pressure from the drive belt tension air cylinder.

8. Remove the two compressor drive belts from the clutch rotor (pulley).

9. Disconnect the coil electrical lead.

10. Ensure that clutch rotor does not rotate, then remove the capscrew, lock washer, and two flat washers mounting clutch to compressor shaft.

CAUTION: Any bolts installed in the armature puller holes must have stop nuts in place to prevent insertion into the armature more than ⅜" (9.5 mm). This will prevent damage to the bearing seal.

11. Remove the rotor and armature assembly, along with the locking key, from the compressor shaft.

12. Inspect the coil for damaged electrical leads, bent or cracked mounting plate, or cracked coil potting compound. Electrical resistance between connector terminals of the coil should be 5.15-5.69 ohms. Resistance from either terminal to the coil case (ground) should be infinite or open. Replace the coil if defective.

CAUTION: Before installing new clutch components, thoroughly clean compressor half flange and shaft seal cover plate of all dirt and grease. Use a clean cloth and suitable cleaning solvent. Dry cleaned surfaces thoroughly with compressed air.

Proceed as follows to install clutch:

13. To install the coil, place it over the shaft seal plate and align the mounting holes. Coil leads should be at the 4 o'clock position.

CAUTION: If the coil will not seat, do not draw it down flush by tightening the mounting capscrews. This will distort the coil mounting and cause misalignment between coil and clutch rotor.

14. When coil is capable of flush mounting, install belt tension cylinder mounting bracket and coil with the four capscrews. Tighten the capscrews to 25-30 lb.-ft. (34-40) Nm) torque.

15. Install the rotor and armature assembly on the compressor shaft. Align the keyways and install the locking key, large and small flat washers, lock washer and capscrew. Hand tighten capscrew.

16. Insert a .020" (.508 mm) feeler gauge between the O.D. of the coil and the coil cavity of the rotor. See figure 16-49. Holding the feeler in position, turn the rotor one revolution to check for proper coil-rotor clearance. If rotor turns freely, without binding, continue installation.

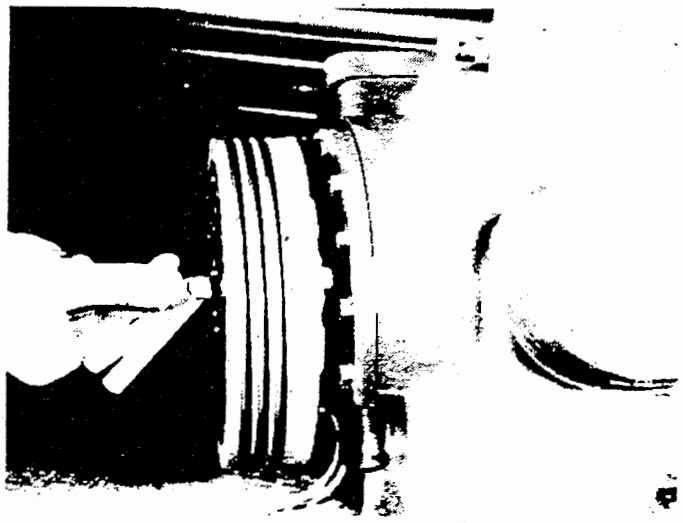
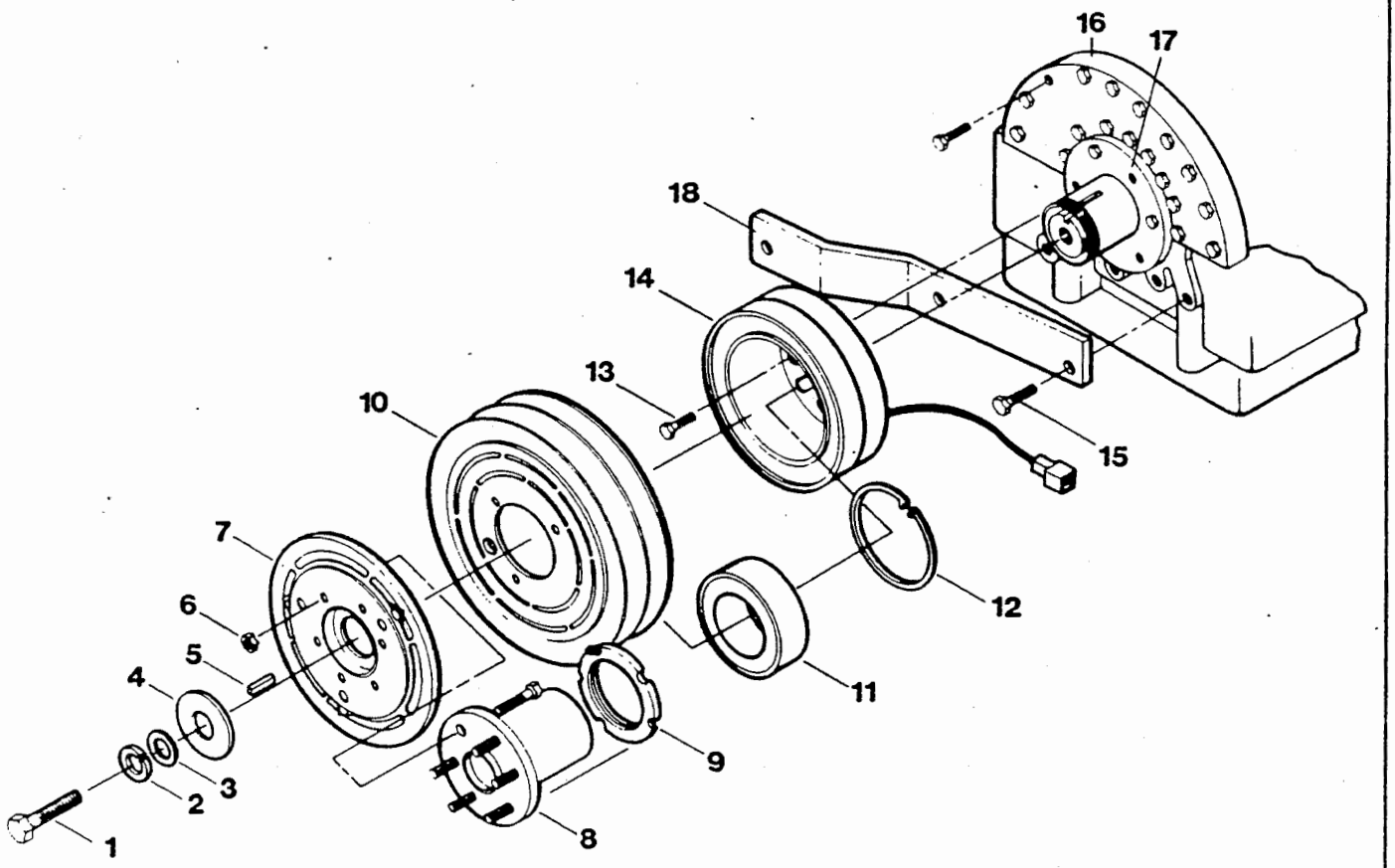


Figure 16-49: Checking Coil - Rotor Clearance

17. Taking appropriate measures to prevent the crankshaft from rotating, tighten the mounting capscrew to maximum 20 lb.-ft. (27 Nm) torque.

CAUTION: Any bolts installed in the armature puller holes must have stop nuts in place to prevent insertion into the armature more than ⅜" (9.5 mm). This will pre-



1. Capscrew
2. Lock Washer
3. Washer
4. Washer
5. Key
6. Nut
7. Armature
8. Armature Hub
9. Locking Nut (greasable)
10. Rotor (pulley)
11. Bearing
12. Retaining Ring
13. Capscrew
14. Coil
15. Capscrew
16. Compressor Half Flange
17. Bearing Mounting Hub
18. Belt Tightening Cylinder Bracket

Figure 16-50: Housing-Mounted Compressor Clutch

vent damage to the bearing seal, loss of bearing grease and clutch burn-out.

18. Replace compressor drive belts and close the manual valve to charge the belt tensioning air cylinder.

HOUSING-MOUNTED CLUTCH MAINTENANCE - The housing-mounted compressor clutch on the coach (figure 16-50) requires bearing lubrication periodically after the initial 5,000 miles (8,000 km). The frequency of lubrication is once per year, in the spring when the air conditioning system is being checked for operation. The point of lubrication is the grease fitting on the bearing retaining nut. Perform the following procedure to grease the bearing:

1. Open the two-way manual valve to vent air pressure from the drive belt tension air cylinder.
2. Remove the two A/C drive belts from the compressor clutch rotor.
3. Disconnect the coil electrical connector.
4. Insert tool 20-296 into two of the three threaded holes in the armature. See figure 16-51. This is to prevent the armature from rotating.

CAUTION: Do not attempt to restore proper air gap by inserting or removing shims. Clutch failure and air conditioning compressor damage may result. After initial air gap adjustment when clutch is installed, shim pack should not be changed.

Bearing failure is usually associated with loss of lubricant from within the bearing. The lubricant may be deposited on the clutch faces and cause slippage. In cases where such slippage is suspected, the coach air conditioning system should not be used until the clutch is repaired, according to the following procedure.

REMOVAL AND DISASSEMBLY:

1. Open the two-way manual valve to vent air pressure from the drive belt tension air cylinder.
2. Remove the two A/C drive belts from the compressor clutch rotor (pulley).
3. Disconnect the coil electrical connector.

NOTE: To make sure armature does not rotate in the following step, use of special tool 20-296 is recommended.

4. Remove retaining capscrew, lock washer and flat washer from compressor crankshaft. See figure 16-41.
5. Install a ⅞-14 x 2" (51 mm) capscrew into the center hole of the armature. Use this capscrew as a jacking bolt to draw the armature from the compressor crankshaft. Secure armature with tool 20-296 as in step 4. See figure 16-52.

CAUTION: Do not use a puller or pry bar against the armature or the end plate. To do so will cause damage to the armature assembly.

6. Remove the armature (figure 16-53).
7. Using special tool number 20-294, remove the rotor retaining nut. See figure 16-54.

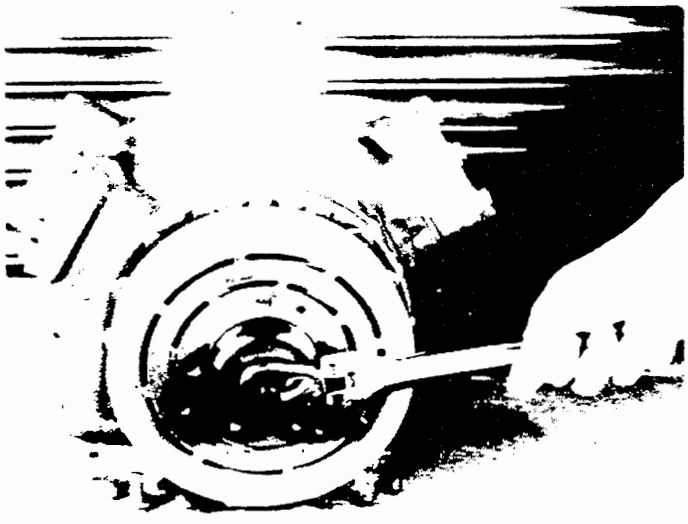


Figure 16-54: Removing Rotor Retaining Nut

8. Install the gear puller into the three threaded holes of the clutch rotor. Refer to figure 16-55.

CAUTION: Use a washer, bushing or spacer to protect the end of the compressor crankshaft from being damaged by the gear puller. Do not use a puller mounted in the belt grooves of the rotor.

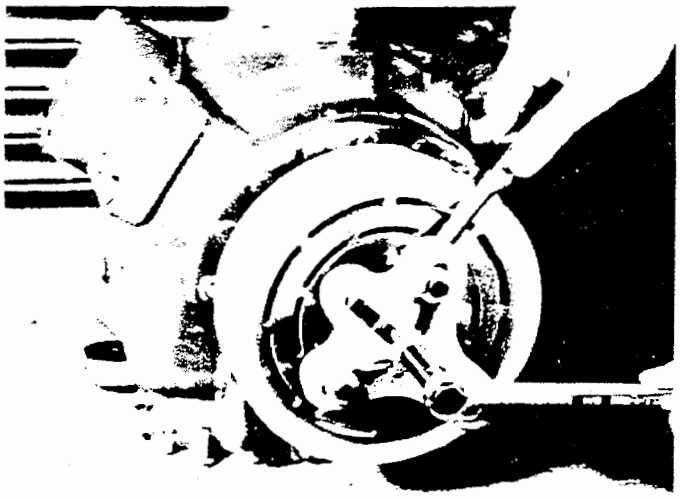


Figure 16-55: Removing Pulley

9. Rotate the puller bolt with a wrench and, while holding the rotor with a bar to prevent movement, draw the pulley from the bearing mounting hub. See figures 16-55 and 16-56.

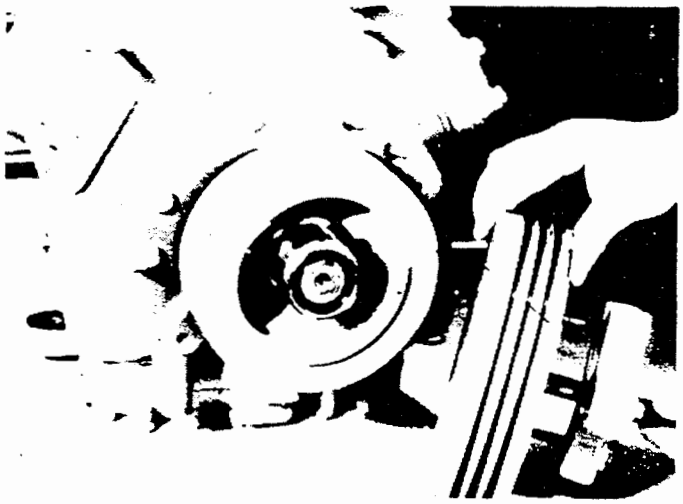


Figure 16-56: Pulley Removed

10. Remove the three capscrews mounting the coil to the flange of the clutch bearing mounting hub. Remove the coil by pulling straight back.

CAUTION: Do not pry coil from mounting flange. To do so may bend coil mounting plate and cause misalignment of coil and rotor cavity.

MC-9 MAINTENANCE MANUAL

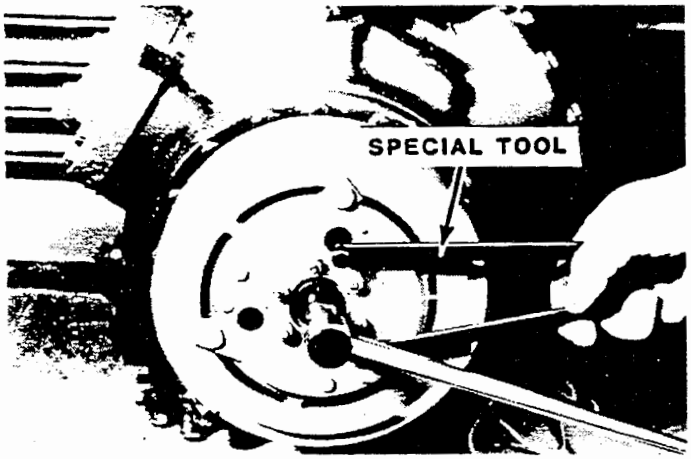


Figure 16-51: Capscrew Removal

5. Remove the retaining capscrew, lock washer and flat washer from compressor crankshaft.

6. Install a ⅞-14 x 2" (51 mm) capscrew into the center hole of the armature. Use this capscrew as a jacking bolt to draw the armature from the compressor crankshaft. Secure armature with tool 20-296, as in step 4. See figure 16-52.

CAUTION: Do not use a puller or pry bar against the armature or the end plate. To do so will cause damage to the armature assembly.

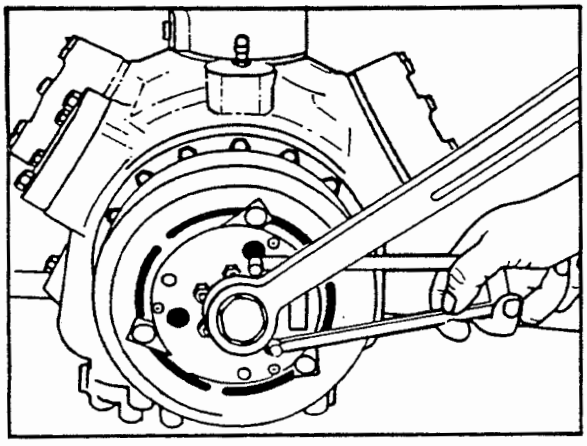


Figure 16-52: Armature Removal with Jacking Bolt

7. Remove the armature (figure 16-53).

CAUTION: The requirement to remove the armature in order to grease the clutch bearing is to provide a means to clean excess grease from the clutch faces. This reduces the potential for clutch slippage, damage, and reduced torque transmission to the compressor. Modification of the clutch or the procedure to grease the bearing is unauthorized and will void the warranty covering the clutch and compressor.

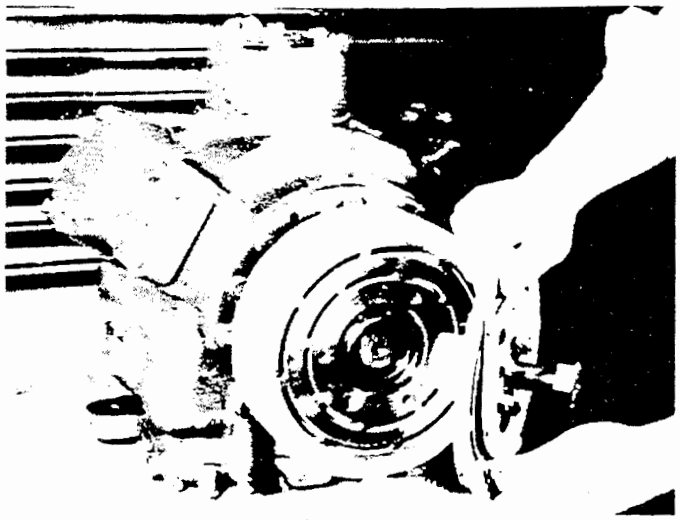


Figure 16-53: Armature Removal

8. Wipe the grease fitting clean of all dirt and foreign material.

9. Using a manual grease gun with an approximate 0.1 oz. (2.835 g) delivery per stroke, insert 1 ounce of grease into bearing. Grease must be **Chevron SR1-2.**

CAUTION: Do not give extra grease to the bearing "for good measure." Excess greasing will cause clutch slippage, overheated clutch parts and clutch failure.

10. Wipe all grease spills from clutch faces, retaining nut, hubs and washers. Use a clean cloth dampened in degreasing agent trichloroethane to clean clutch faces.

11. Install armature, flat washer, lock washer and armature retaining capscrew on compressor crankshaft. Tighten capscrews to 16-20 lb.-ft. (22-27 Nm) torque.

12. Connect coil electrical lead, install drive belts and close two-way manual air valve.

Every 50,000 miles (80,000 km) clutch face wear should be measured according to the following procedure:

CAUTION: Clutch coil must be de-energized. If this procedure is done with the clutch mounted to the compressor while installed in the coach, ensure the engine starter cannot be engaged.

13. Using a depth micrometer, measure and record the distance from the back of the armature to the face of the rotor (air gap). See figure 16-48.

14. Disconnect the clutch coil electrical connector. Ground one connector terminal and connect 24 VDC to the other terminal to energize the clutch coil.

15. Repeat step 13 for the measured distance when the armature and rotor faces are engaged.

16. Determine the difference between the two measurements. If the difference exceeds .110" (2.794 mm), the clutch rotor and armature require replacement. Proceed to Removal and Disassembly, below.

If it is necessary to remove the bearing from the rotor, follow these steps:

1. Remove the retaining ring from the rotor bore (figure 16-50).
2. Using the proper-sized arbor, press the bearing from the rotor.

INSPECTION:

1. Check the bearing for evidence of lubricant leakage, looseness or excessive free play from inner race to outer race. Check also for "roughness" in movement when inner and outer race are rotated in opposite directions. Replace the bearing if worn or defective.

NOTE: Bearing replacement is recommended any time the compressor clutch is serviced after 150,000 miles (240,000 km), regardless of its apparent condition.

2. Inspect the faces of both the rotor and armature assemblies. Surfaces should be clean and free of discoloration from grease or excessive heat. Check for presence of raised ribs on faces of rotor and armature. Replace both rotor and armature if raised ribs have been flattened or if the faces are contaminated or burned.

CAUTION: Both assemblies must be replaced as a pair. Do not intermix a used component with a new one. Premature clutch failure will result.

3. Inspect the coil for damaged electrical leads, bent or cracked mounting plate, or cracked coil potting compound. Electrical resistance between connector terminals of the coil should be 5.15-5.69 ohms. Resistance from either terminal to coil case (ground) should be infinite or open. Replace the coil if defective.

INSTALLATION

1. Position coil on clutch mounting hub with electrical leads at 4 o'clock position. Align the mounting holes.
2. Install the coil-mount capscrews and tighten to 25-30 ft.-lb. (34-41 Nm) torque.

CAUTION: Do not draw coil onto flange with the capscrews. Distortion of the coil and misalignment will result.

3. If clutch bearing is not installed in rotor, do so using arbor and press. Install retaining ring.
4. To ease installation of the rotor onto the clutch bearing mounting hub (on compressor), preheat inner race of rotor bearing. A 75-100 watt outdoor post lamp-style bulb, placed in the bearing for 15-30 minutes, will heat the race.

CAUTION: Do not heat the bearing with open flame. Bearing must not be heated more than 175°F (79°C).

5. When bearing is heated, slide rotor assembly onto clutch bearing mounting hub. Use rotor installation tool 20-296 seated against the bearing inner race and tap lightly until bearing bottoms against flange. See figure 16-57.

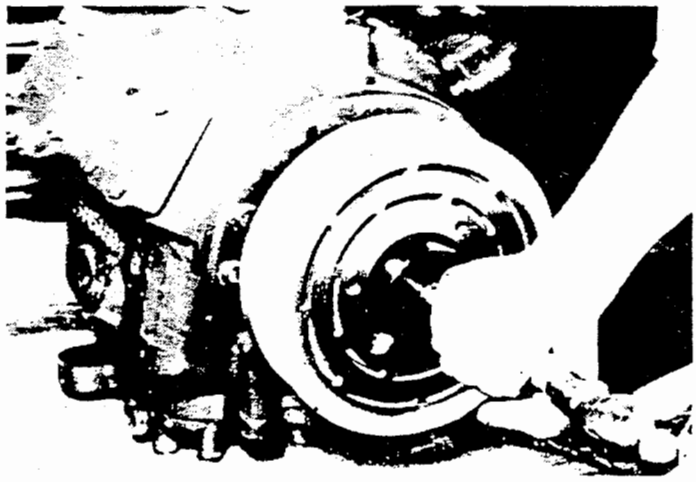


Figure 16-57: Installing Rotor/Bearing Assembly

6. Install bearing retaining nut, using tool 20-294 and a torque wrench. See figure 16-58. Due to the self-locking feature of the nut, observe the torque required to seat the bearing against the hub. After the bearing seats, tighten the nut 50 lb.-ft. (68 Nm) greater than the bearing-seating torque.

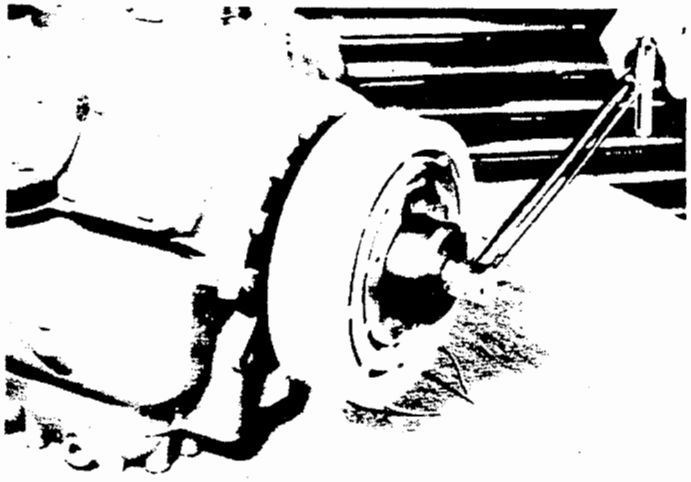


Figure 16-58: Tightening Bearing Retaining Nut

7. Check coil-to-rotor clearance with feeler gauge .020" (.508 mm) thick by .156" (.842 mm) wide (max.). Insert the feeler gauge through a slot in the rotor face (figure 16-59) so it extends beyond the rear of the rotor. Slowly rotate the rotor one full revolution. The feeler should not rub or bind against the coil shell. Make the test through several evenly spaced slots around the rotor circumference.

NOTE: If the feeler gauge check shows misalignment between the rotor and field shell, determine the cause. The field mounting bracket must be flat and not distorted.

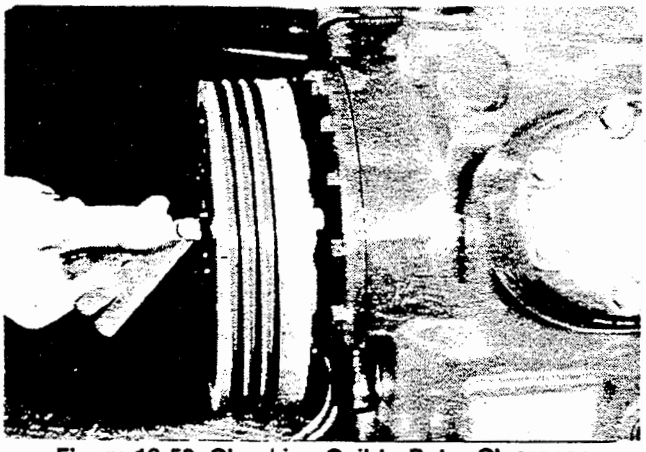


Figure 16-59: Checking Coil-to-Rotor Clearance

8. Place the armature and hub assembly onto the compressor crankshaft. Align the keyway slots in the crankshaft and armature hub.

9. Install the key into the keyways. Make sure the outer end of the key is flush with the hub counterbore.

10. Install the flat washer, lock washer and capscrew to secure the armature to the shaft. Tighten the capscrew to 16-20 lb.-ft. (22-27 Nm) while using tool 20-296 to prevent armature rotation.

NOTE: The remainder of this procedure applies to new clutch installations only.

11. Using a feeler gauge, measure and record the air gap between the rotor face and the armature face. See figure 16-60.

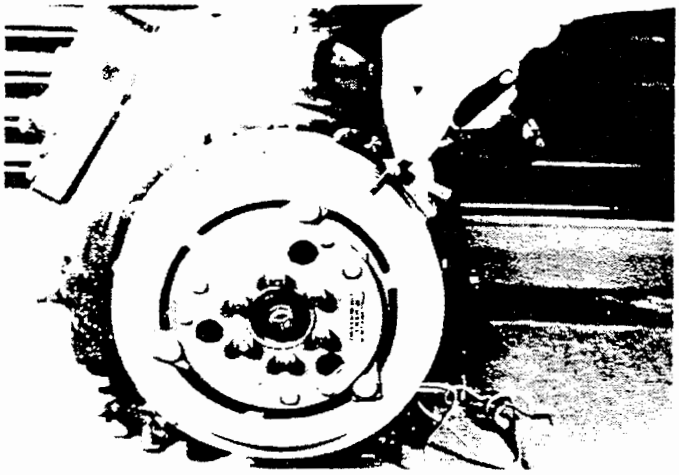


Figure 16-60: Measuring Rotor-to-Armature Air Gap

12. Determine if the air gap as measured meets the required air gap of .045 ± .015" (1.143 ± 0.381 mm).

NOTE: Shims have been factory installed between the armature and the armature hub. There are six .020 shims and one .010 shim; one or more of them may require removal in order to achieve the proper air gap for new clutch installations.

13. Determine which shims should be removed, if any, for the .045 ± .015" (1.524 ± 0.381 mm) air gap.

NOTE: The remainder of this procedure is necessary only if air gap is not within .030"-.060" (.762-1.524 mm).

14. Install tool 20-296 to prevent armature rotation and remove the six armature-to-hub retaining nuts and washers (figure 16-61).

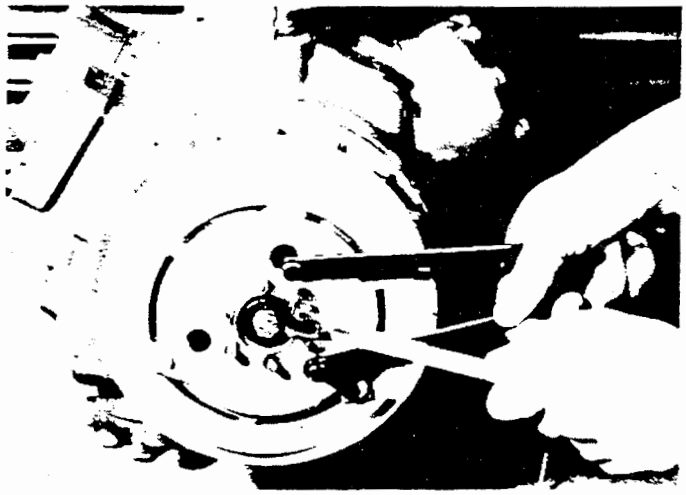


Figure 16-61: Removal of Armature Retaining Nuts

15. Remove the armature plate and the required shims for the correct air gap.

16. Insert a .020" (.508 mm) feeler gauge between the outside edge of the clutch bearing mounting hub and the inside edge of the armature mounting hub. See figure 16-62. If the clearance is less than .020" (.508 mm), clutch installation to this point is not correct. Determine the reason for the clearance discrepancy and correct before proceeding.

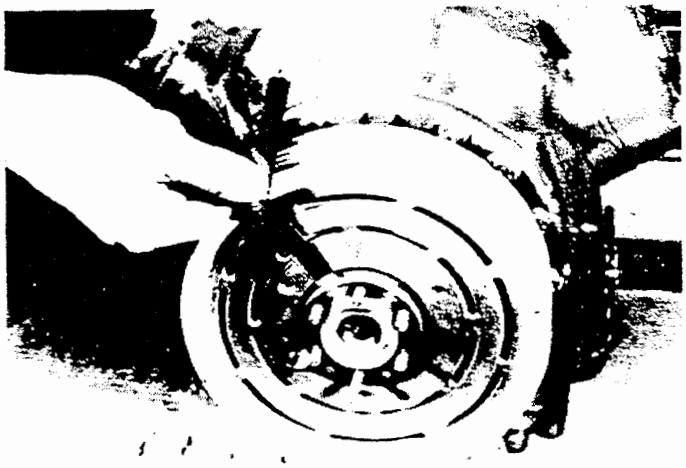


Figure 16-62: Checking Bearing Hub and Armature Hub Clearance

17. Reinstall the armature plate, washers and nuts. Tighten nuts to 7 lb.-ft. (9.5 Nm) torque.

18. Check for the proper air gap between clutch faces. If satisfactory, procedure is complete.

MC-9 MAINTENANCE MANUAL

SPECIFICATIONS

COMPRESSOR
- Manufacturer ..... Carrier Transicold
- Model 05GE037110
- No. of Cylinders 6
- Bore ..... 2" (50.8 mm)
- Stroke ..... 1-15/16" (49.2 mm)
- Operating Speed .... 400 to 2200 rpm (1750 rpm nominal)
- Minimum Speed (for lubrication) ..... 400 rpm
- Horsepower ..... 25, nominal
- Oil Presure at 1750 rpm ..... 15 to 30 psi (103.5-207 kPa) above suction pressure
- Oil Change ..... 9 pints (4.03 liters)
- Weight ..... 142 lb. (64.5 kg)
- Recommend Oil ..... Texaco WF 68 WF1 132

APPROVED COMPRESSOR OILS
- Dupont ..... Zephron 150
- Sun Oil Company ..... Sunisco 3GS
- Texas Oil Company WF1 132 WF68

The above oils are suitable for use with reciprocating compressors using Freon 12 with evaporator temperature above -40°F (-40°C).

APPROVED CLUTCH GREASE ..... Chevron SR1-2

REFRIGERANT
- Type ..... Freon 12 (Dichlorodifluormethane)
- Quantity ..... 24 lbs. (10.8 kg)

RECEIVER TANK
- Manufacturer ..... Standard Refrigeration Co.
- TMC/MCI Part No. 16R-5-2

CONDENSER COIL
- Manufacturer ..... Carrier
- TMC/MCI Part No. 16B-4-1

FILTER DRYER
- Manufacturer ..... Henry Valve
- TMC/MCI Part No. 16F-10-13

CONDENSER FAN AND MOTOR
- Manufacturer ..... Ohio Electric
- Type ..... 24 Volt, 2 hp continuous duty
- RPM 2200
- Amperage Draw ..... Rated 71 Amp ..... Average 52 Amp
- TMC/MCI Part No. 16G-9-20

EVAPORATOR COIL
- Manufacturer ..... Carrier
- TMC/MCI Part No. 16R-6-1

EVAPORATOR FANS AND MOTOR
- Manufacturer ..... Reliance Electric
- Model C-3087
- Type ..... Single speed continuous duty
- Horsepower (kw) ..... 1½ hp (1.1 kw)
- Volt ..... 24-28 Volts
- Rotation ..... CW-Commutator End
- Amperage Draw ..... Start-Up 70 amps ..... Running 53 amps
- RPM 2900
- TMC/MCI Part No. 16G-8-33

TORQUE SPECIFICATIONS

SIZE DIA. (IN.)	THREADS PER IN.	TORQUE RANGE FT.-LB.	TORQUE RANGE Nm	LOCATION
1/16	27 (pipe)	8-12	10-16	Pipe Plug - Crankshaft
1/4	20 (pipe)	20-25	27-34	Oil Return Check Valve - Crankcase
	20 (pipe)	20-25	27-34	Pipe Plug - Pressure Gauge Connection
	20	8-10	10-13	Connecting Rod Cap Screw
	28	12-16	16-32	Unloader Valve
	28	6-10	8-13	Oil Pump Drive Segment
No. 10	32	4-6	5-8	Oil Pump Drive Segment
5/16	18	16-20	22-27	Cover Plate - Pump End Bearing Head Suction Valve Discharge Valve Suction Valve Adapter - Crankcase
3/8	16	25-30	34-41	Pump End Bearing Head Bottom Plate - Crankcase Compressor Foot Seal Cover
	16	30-35	41-48	Cylinder Head
7/16	14	55-60	75-81	End Cover - Crankcase
1¼	18 NEF	35-45	47-61	Oil Level Sight Glass

MC-9 MAINTENANCE MANUAL

SIX CYLINDER COMPRESSOR

COMPRESSOR WEAR LIMITS

PART NAME	FACTORY MAXIMUM		FACTORY MINIMUM		MAXIMUM WEAR BEFORE REPAIR	
	INCHES	mm	INCHES	mm	INCHES	mm
SEAL END						
Main Bearing Diameter	1.8760	47.6504			.002	0.051
Main Bearing Journal Diameter			1.8725	47.5615	.002	0.051
PUMP END						
Main Bearing Diameter	1.3755	34.9377			.002	0.051
Main Bearing Journal Diameter			1.3735	34.8869	.002	0.051
CONNECTING ROD DIAMETER	1.3755	34.9377			.002	0.051
Piston Pin Bearing			.6878	17.4701	.001	0.0254
CRANKPIN DIAMETER			1.9356	49.16	.0025	0.0635
Throw	1.9396	49.27				
THRUST WASHER (THICKNESS)						
Pump End	.145	3.683	.144	3.658	.040*	1.016
Seal End	.157	3.987	.155	3.937	.040*	1.016
CYLINDERS AND PISTONS	2.0005	50.8127			.002	0.051
Bore			1.996	50.0698	.002	0.051
Piston			.6873	17.4574	.001	0.025
Piston Pin Bearing			Thumbfit			
Piston Ring Gap	.013	0.33	.005	0.127	.025	0.635
Piston Ring Side Clearance	.002	0.051	.001	0.0254	.002	0.051
SUCTION VALVE RECESS (Depth)	.082	2.08	.078	1.98	.090	2.286

* MAXIMUM END CLEARANCE BETWEEN THRUST WASHER AND SHAFT

Date 1-1-89

MC-9 MAINTENANCE MANUAL

SECTION 17

LAVATORY

SUBJECT	PAGE
Air Operated Flush System	17-8
Deodorizer	17-3
Dome Light	17-3
Door Lock	17-3
Door Lock Air Cylinder	17-3
Emergency Buzzer	17-2
Engine Vacuum Ventilation System	17-2
Fresh Water Tank	17-10
Lavatory Components	17-2
Lavatory Description	17-1
Lavatory Service Panel	17-5
Occupied Sign	17-3
Soap Dispenser	17-3
Specifications	17-11
Thermal Drain Valve	17-10
Towel and Tissue Dispensers	17-2
Troubleshooting	17-9
Ventilation Blower and Motor	17-1
Service Bulletin Page	

MC-9 MAINTENANCE MANUAL

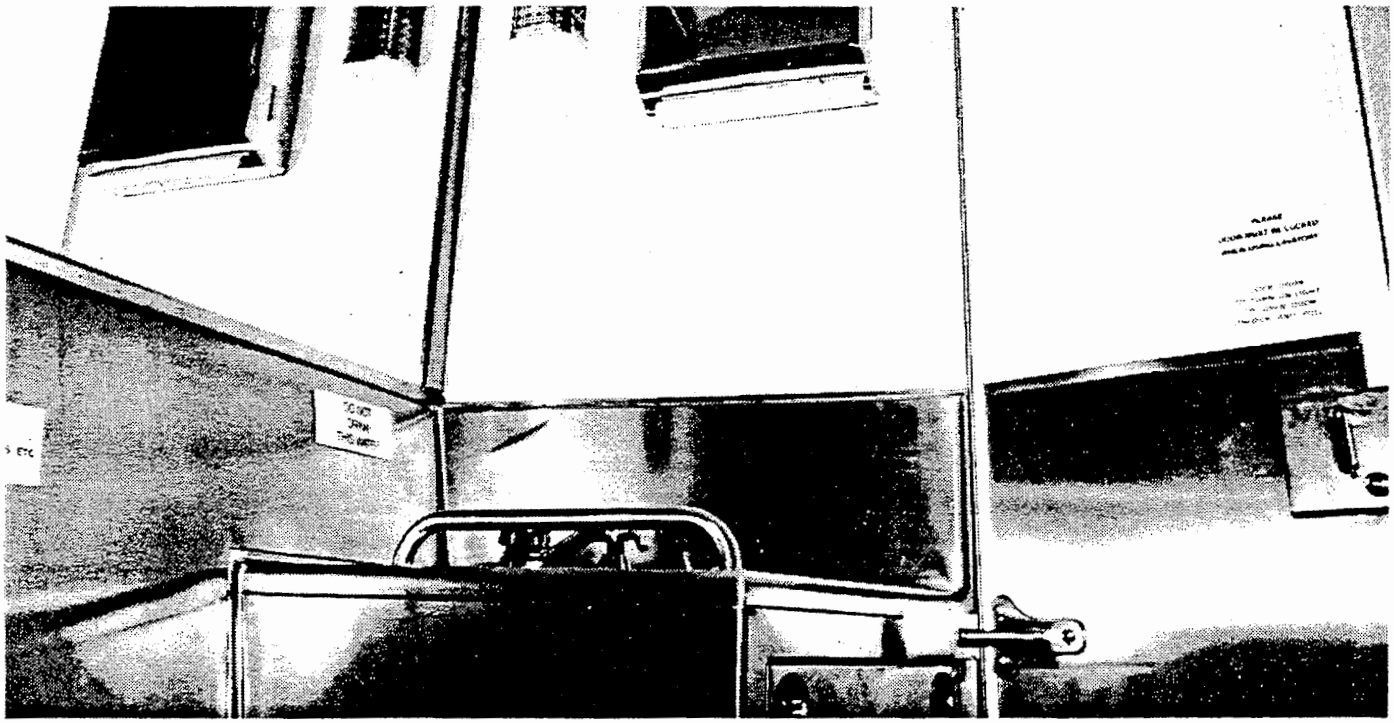


Figure 17-1. Lavatory.

LAVATORY

DESCRIPTION

Washroom facilities are installed at the right rear corner of the coach. Installation of the washroom eliminates seating for two passengers, leaving three seats on the rear cross seat.

The washroom (figure 17-1) has a special, embossed stainless steel floor with stainless steel bright finish paneling on the lower half of the walls, door and sink partition. Permanent finish melamine panels are utilized on the upper half of the washroom partitions for ease of cleaning and resistance to damage. A large mirror is mounted on the back wall above the wash basin. Extreme care has been taken in the design of the washroom to avoid corners where dirt may collect. The use of stainless steel enables the washroom to be easily maintained in a pleasing condition at all times.

A single waste water and chemical tank with bottle stop in drop tube is used. A stainless steel fresh water tank for the wash basin is located in the interior of the coach behind the wall mirror. A large overflow line is provided on the fresh water tank to eliminate the possibility of damage by excessive water pressure. A manually operated slide dump valve is provided to drain the chemical tank.

A coupling which provides water to the fresh water tank is easily accessible through a small door on the right rear side of the vehicle. A coupling for flushing and filling the chemical tank is accessible through the right hand rear side engine service door.

VENTILATING BLOWER AND MOTOR

A ventilator blower mounted on the chemical tank exhausts odors and also provides constant air circulation to the lavatory compartment. Air enters the lavatory compartment through a duct on the outer wall which discharges behind the window release bar.

The exhaust blower operates whenever the master control switch on the driver's instrument panel is put in the ON position. The blower motor is rubber mounted and can easily be removed from the engine compartment by removing the mounting screws and separating the electrical wires at the connectors.

NOTE: Later production coaches have a ventilation system without the blower and motor (unless the blower and motor have been retained by special request). Information on this newer system will be found later in this section.

MAINTENANCE

The frequence of preventative maintenance should be determined by coach mileage and the operating conditions. However, these items should be checked approximately every 50,000 miles (80,000 km) or 1,700 coach operating hours.

Remove the blower and motor assembly (see figure 17-2). Free operation of blower wheel and motor is important. Check blower housing wheel and ducts. If dirty, they should be cleaned.

Check motor brush seating and amount of wear. If not seating properly or worn, the brushes should be replaced. They can be replaced without removing the unit from its mounting.

REMOVAL AND INSTALLATION

1. Open right hand rear side service door.
2. Disconnect wiring.

NOTE: Tape ends for safety purposes.

3. Loosen clamp attaching flexible air hose to blower shroud and remove hose.
4. Remove the screws which attach blower assembly, then remove motor with fan and housing assembly.

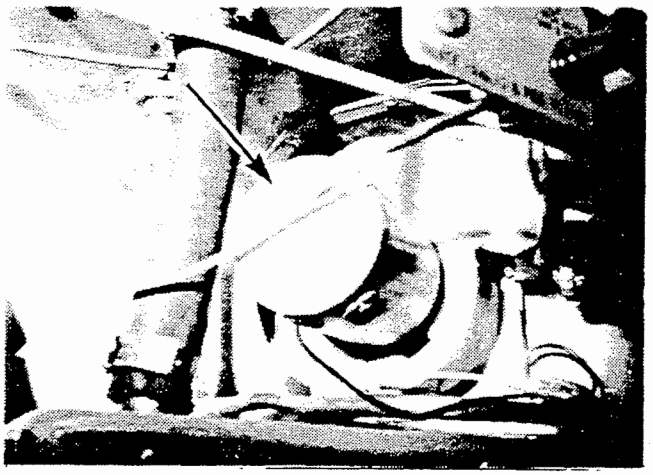


Figure 17-2. Lavatory Ventilating Blower and Motor (On Earlier Coaches).

5. To install, place blower motor with fan and housing in position, then attach with four capscrews.

6. Install flexible air hose to blower shroud and attach with clamp.

7. Connect electrical wiring and tape the wiring connections securely.

8. Check motor operation.

ENGINE VACUUM POWERED VENTILATION SYSTEM

The lavatory ventilation system installed on later production coaches operates off the engine vacuum. A large air hose connects the lavatory drop tube to the engine air intake box. The constant vacuum thus applied to the drop tube causes a continuous flow of fresh air from the duct on the outer wall of the lavatory to pass through the lavatory compartment (figure 17-3).

A drain line from the air exhaust elbow on the drop tube keeps moisture from accumulating in the exhaust hose and from entering the air intake box. See figure 17-4.

LAVATORY COMPONENTS

Various items associated with the lavatory are described below. Refer to figures 17-1 and 17-5 for their locations.

TOWEL AND TISSUE DISPENSERS

A towel dispenser is mounted on the inside of the lavatory above the sink. See figure 17-1. Also a "Towelette" wet towel dispenser is mounted on the inside of the lavatory wall above the sink. These towels can be used for washing and drying when temperature is below 32°F (0°C).

A tissue dispenser is mounted at the lavatory front wall. A key is furnished for refilling dispenser.

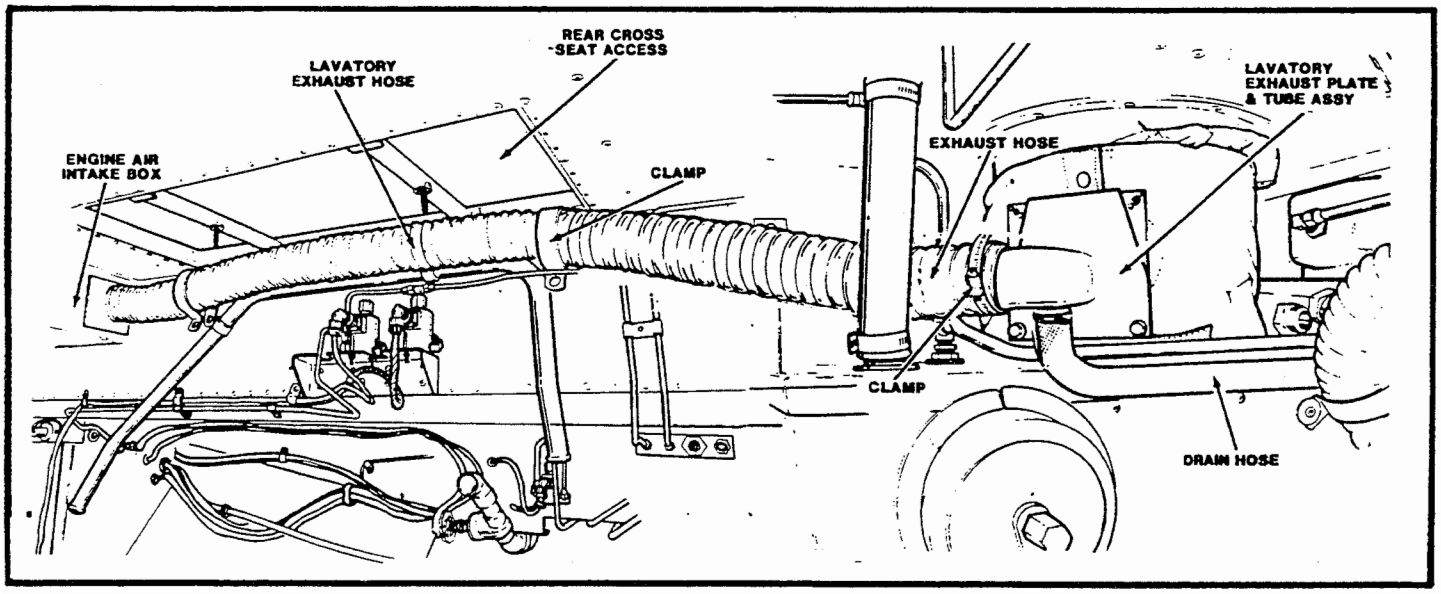


Figure 17-3. Vacuum Operated Lavatory Ventilation System.

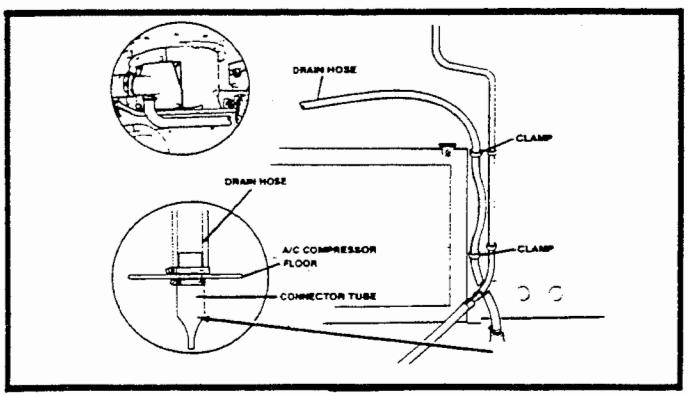


Figure 17-4. Drain Hose Installation.

EMERGENCY BUZZER

The lavatory emergency buzzer is mounted in the front junction box and sounds when the emergency switch button in the lavatory compartment is pushed. Refer to wiring diagram for circuit continuity.

The emergency buzzer switch marked "To Signal Driver - Emergency Only" is located on upper right corner of the front

partition of the lavatory compartment. A light on the instrument panel marked "Lavatory Alarm" illuminates and a buzzer sounds when the switch is depressed

DEODORIZER

A block refill-type deodorizer is mounted on the side compartment partition. To install a new block, open the grille-cover and place the block on the platform.

OCCUPIED SIGN

A lavatory occupied sign light is located on the exterior of the forward lavatory compartment partition. This sign which reads "Wash Room Occupied" is illuminated when the lavatory door is closed and locked.

DOOR LOCK

The lavatory door lock has both inside and outside handles and an inside latch to lock door from within the compartment. When this latch bolt is locked it automatically turns on the compartment ceiling light and the exterior occupied sign light. If the lock fails to release, the door can be opened from the outside with a special key which is furnished to the driver.

The lock assembly can be removed from the door, then readily disassembled and the parts replaced, if necessary. A light application of lubricant to all moving parts will assure free operation.

DOME LIGHT

A microswitch is installed in the door post at the edge of the front partition. This switch is activated by the door lock mechanism upon locking to energize the dome light and the "Washroom Occupied" sign on the outside wall. The switch is readily serviced by removing the two screws securing the striker plate to the post.

The lavatory dome light contains a 6-candlepower bulb that lights with the marker lights and a 32-candlepower bulb that lights when the door is closed and locked.

SOAP DISPENSER

To refill the liquid soap dispenser, unscrew the plunger cap which is threaded into the dispenser body. Remove cap and pour liquid soap into dispenser tank until full. Replace plunger cap into dispenser body.

Periodic cleaning of soap dispensing equipment should be made a regular part of your washroom cleaning routine and general maintenance program.

Sometimes a dispenser is considered in need of repair when it may only be clogged and in need of a good cleaning. As a general rule, all soap dispensing equipment should be flushed out once a month to remove soap residue and dirt.

The exterior of the soap dispenser should be washed with warm soap and water, then dried with a clean cloth.

Never use abrasive cleaners on parts of the soap dispenser as this will mar the surface.

If it becomes necessary to remove the soap dispenser for cleaning, this procedure should be followed:

1. Remove the soap container from the cover.
2. Place a small chain, 24" (610 mm) long, inside the soap container.
3. Add a small quantity of soap and warm water.
4. Shake the container until the chain has dislodged all film from the interior.
5. After removing the chain, thoroughly rinse the container and let it dry before refilling with soap solution.

As part of your regular routine, make it a practice to check the operating condition of the soap dispensing piston mechanism at regular intervals to make sure it works freely. If it is not working, disassemble and wash all metal parts in soap and water and let dry. Assemble and replace in service.

DOOR LOCK AIR CYLINDER

An air-operated air cylinder (1) is installed to provide positive closing of the lavatory door. The cylinder also reduces rattles and strain on lock, striker plates and hinge.

The cylinder is fed from the coach accessory air supply (4). A pressure regulating valve (2) and a flow control valve (3) assure a controlled closing action (figure 17-6). Refer to Section 4, Brakes and Air System, for detailed maintenance of regulating valve.

The lavatory door air cylinder should be lubricated at regular intervals — approximately every 30,000 miles (48,000 km). The recommended procedure is as follows:

1. Remove air feed hose and put a few drops of SAE 30 oil into the cylinder through the air hose connector.
2. Reconnect the feed hose.
3. Check air cylinder for leaks.
4. When overhauling air cylinder, it is important to replace all seals, felts, cups and O-rings with new parts for proper operation. Also when overhauling cylinder, the new parts should be coated with oil before assembly.

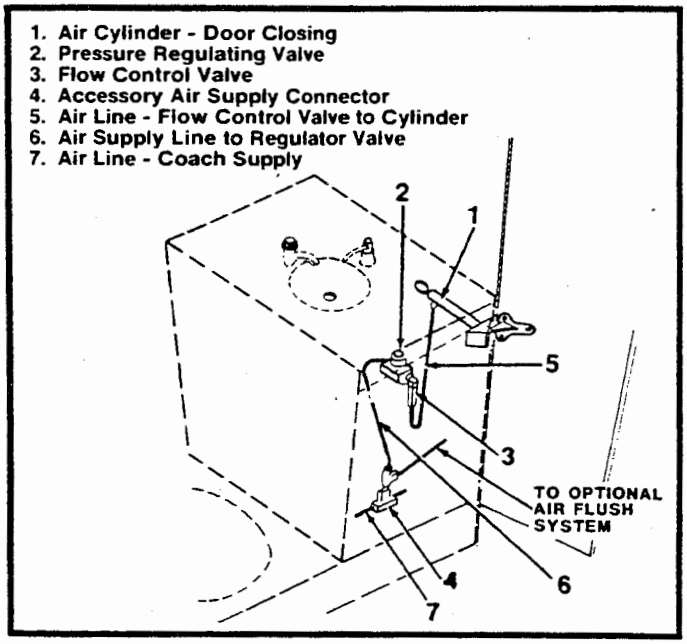


Figure 17-6. Lavatory Door Air Cylinder Installation.

MC-9 MAINTENANCE MANUAL

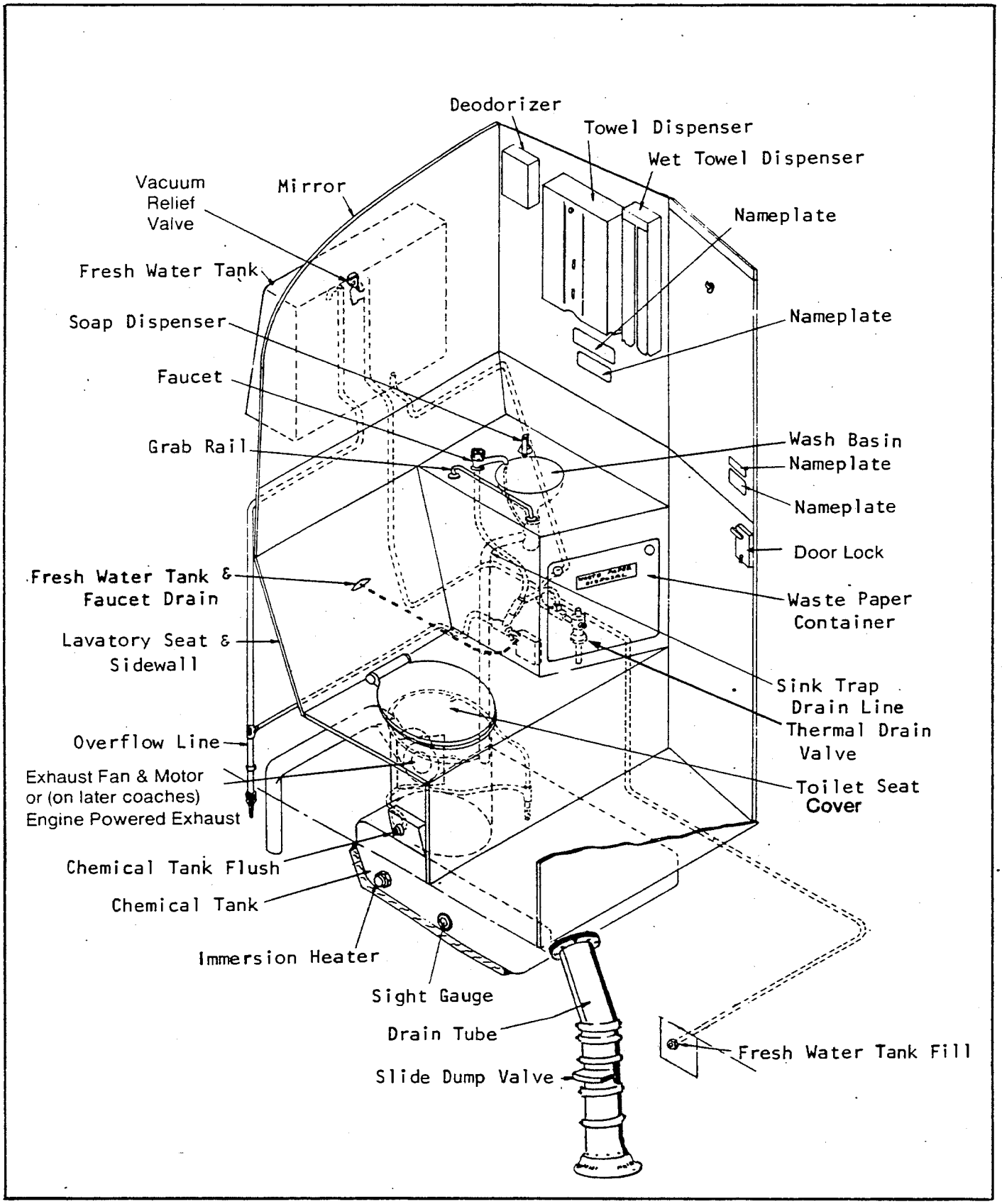


Figure 17-5. Lavatory Components.

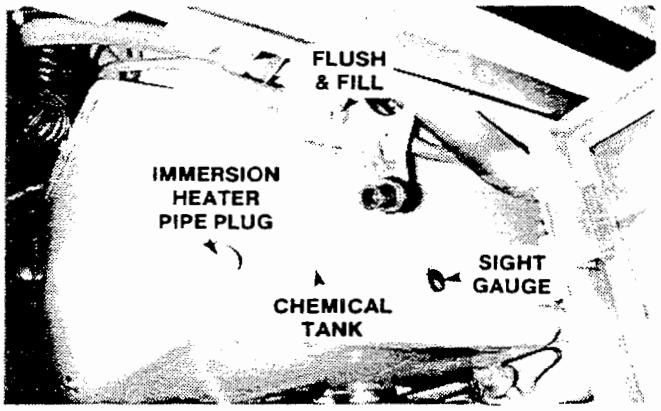


Figure 17-7. Lavatory Service Panel.

LAVATORY SERVICE PANEL

The fresh water fill service panel is located on the exterior right hand rear side. See figure 17-7. Chemical tank flushing and filling service points are located in the engine compartment above the right hand rear side engine service door. A Hansen 6000 series quick connector is used for flushing and filling the chemical waste tank. A Hansen 5000 series quick connector is used for filling fresh water tank (figure 17-8). The flushing and filling inlet cap is made of molded vibrin plastic and a steel link chain is used to attach the cap to the coach body to prevent loss of cap. A lavatory service door assembly incorporates a cup-shaped spring loaded seal to close off the fresh water fill opening.

A manually operated dump valve is located under the chemical tank in the dump tube. To drain the chemical waste tank, pull the handle of the slide dump valve. After draining and flushing, push the handle all the way in. A special hopper in the floor of the service area (or equivalent to local health regulations) with proper flush down facilities should be used to convey waste contents to the sewer system.

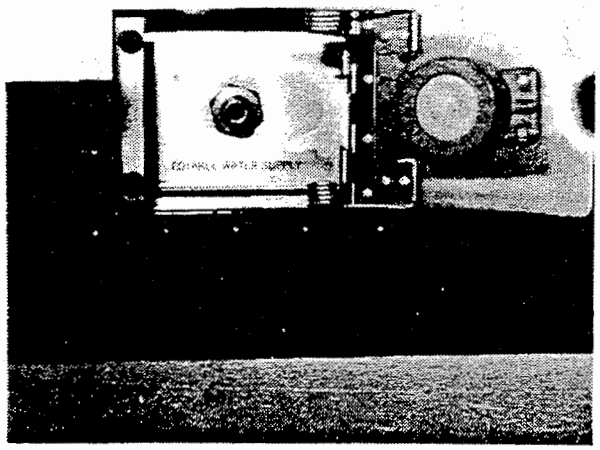


Figure 17-8. Fresh Water Supply Fill Inlet.

WINTERIZING

Although DG-19 will freeze below +30°F. (-1°C.), upon thawing, the performance of the chemical will not be affected.

The most economical way to protect the assembly should it be exposed to extreme cold temperatures, is to use an anti-freeze solution such as ethylene glycol in the waste chemical tank.

Based on the expected average low temperature and the quantity of waste in the waste chemical tank, charge the tank as follows:

	Percentage of Antifreeze Required in Tank			
	25%	33%	40%	50%
Protects To:	+10°F (-12°C)	0°F (-17°C)	-12°F (-24°C)	-34°F (-36°C)

CAUTION: Ethylene glycol can be fatal if a sufficient quantity is swallowed. Do not use automotive "stop-leak" formula which frequently causes coagulation of the flushing fluid when mixed with high quality deodorizing additives.

For better odor control the amount of chemical (DG-19) should be doubled when used in conjunction with antifreeze.

SERVICE AND CLEANING

Servicing of the flush unit and tank (figure 17-9) should be performed at regular intervals or when it becomes necessary.

1. After rinsing the tank, close the drain valve and fill toilet with clean water until the water level reaches sight gauge level.
2. Flush the toilet three more times or until the liquid in bowl becomes clear. This should remove any sediment which may have collected in the pump.
3. Open the drain valve and drain the tank while flushing toilet.
4. Close the drain valve.
5. Recharge unit as per instructions under Charging System.

A thorough cleaning is essential prior to inspection for determining the existence, exact location, and extent of any defects. The assembly may be cleaned by scrubbing the inside and outside surfaces with a solution of soap and water or five tablespoons of liquid disinfectant to each gallon of water. Do not use abrasive cleaners on any part of the assembly. Rinse thoroughly with hot water and dry, using compressed air.

MC-9 MAINTENANCE MANUAL

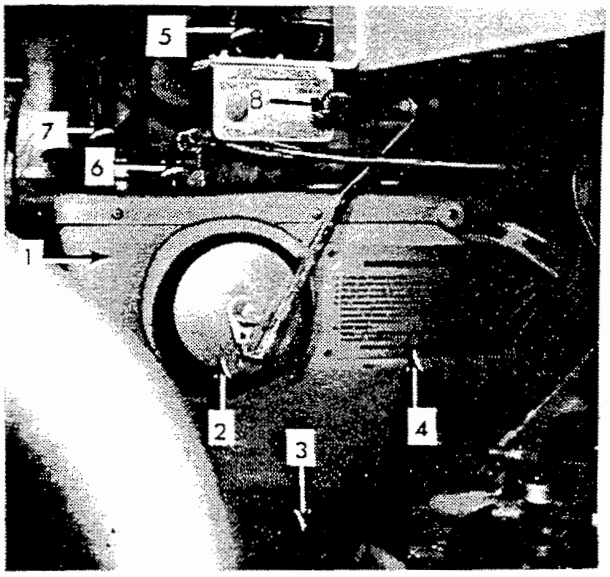
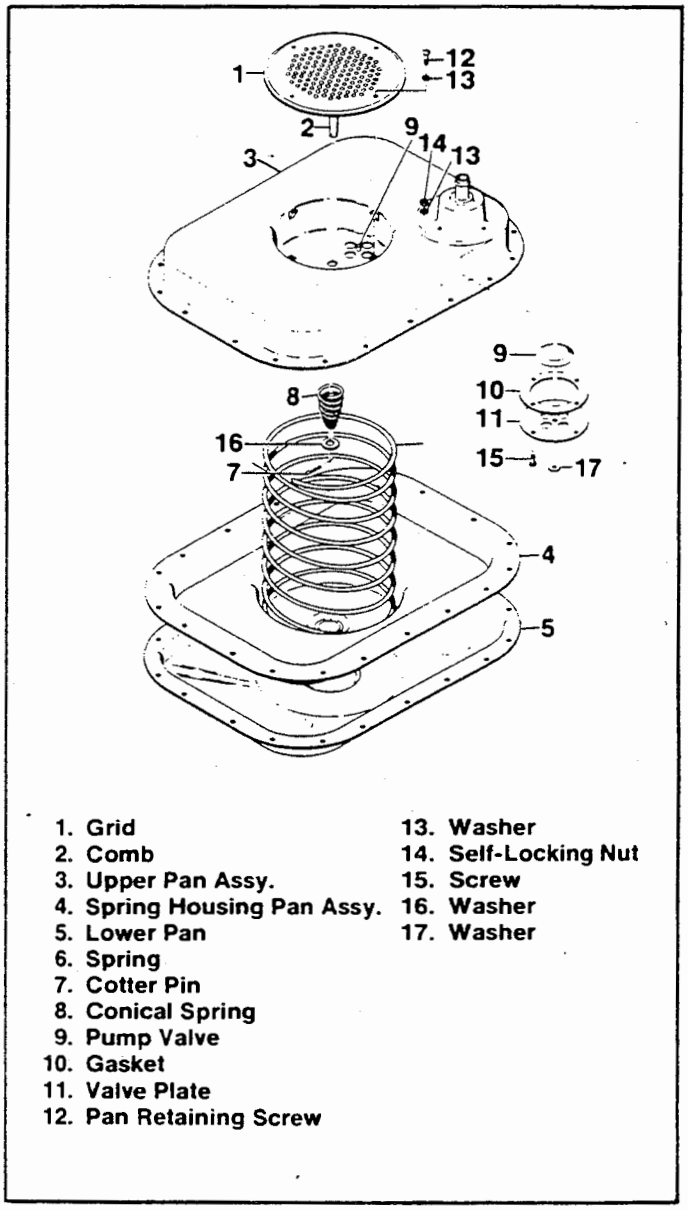


Figure 17-9. Air Flush Chemical Tank.

1. **Chemical Tank**
2. **Clean-Out Plug**
3. **Air Flush Pump**
4. **Nameplate - Servicing Procedure**
5. **Lavatory Exhaust Blower & Motor**
6. **Rinse Tube**
7. **Hose - Sink Drain**
8. **Drain Valve Handle**



1. **Grid**
2. **Comb**
3. **Upper Pan Assy.**
4. **Spring Housing Pan Assy.**
5. **Lower Pan**
6. **Spring**
7. **Cotter Pin**
8. **Conical Spring**
9. **Pump Valve**
10. **Gasket**
11. **Valve Plate**
12. **Pan Retaining Screw**
13. **Washer**
14. **Self-Locking Nut**
15. **Screw**
16. **Washer**
17. **Washer**

Figure 17-10. Air Flush Pump Disassembled.

REMOVAL AND DISASSEMBLY

1. Discharge and clean the waste chemical tank as described under Service and Cleaning.

2. Remove air line from lower pan assembly.

3. Refer to figure 17-10. Remove only the 3/16" (4.7 mm) brass hex nuts that mount the air pump assembly to chemical tank.

NOTE: The 6 small hex nuts should not be removed at this time. Disassembling these will separate both pump halves after the pump is removed.

4. Carefully remove air pump assembly and invert or place it on its side.

5. Remove flexible tubing from the flush outlet port on the air pump assembly.

WARNING: Pump assembly spring is compressed to 25 lbs. (11.3 kg) pre-load. Exercise care during disassembly.

6. Remove lower pan assembly from air pump assembly.

7. Remove retaining ring securing comb and grid.

8. Remove cotter pin securing conical spring. Remove spring and comb stem.

9. Remove screws securing pump valve to flush outlet port.

10. Remove plate and gasket from pump valve.

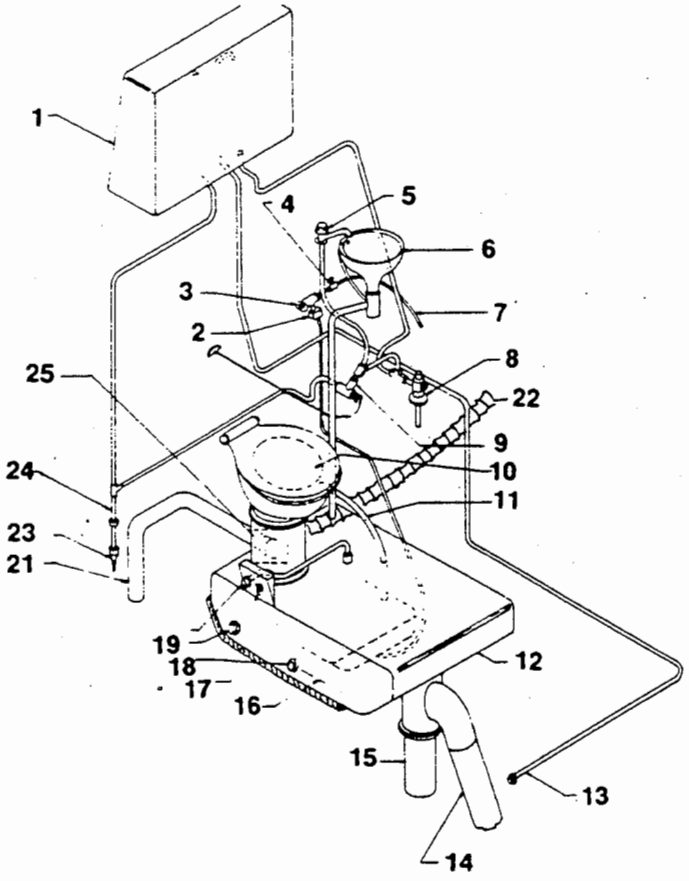
11. Remove pump valve from flush outlet port.

12. Remove spring from spring housing assembly.

Reassemble in reverse order of disassembly.

Figure 17-11 shows the air-operated flush system interconnection. Also see figure 17-12.

MC-9 MAINTENANCE MANUAL



1. Water Tank
2. Quick Release Valve
3. Push Button Valve
4. Pressure Regulating Valve (11 psi/75.7 kPa)
5. Faucet
6. Basin
7. Air Supply Line
8. Automatic Water Drain Valve
9. Manual Drain Valve
10. Toilet Seat
11. Flushing Delivery Hose
12. Chemical Tank
13. Fresh Water Tank Fill Line
14. Dump Tube
15. Air Cylinder*
16. Start Charge Level
17. Air Dump Valve*
18. Sight Glass
19. Immersion Heater Provision
20. Chemical Tank Flush & Fill Tube
21. Exhaust Fan Outlet (on earlier coaches)
22. Engine Powered Exhaust (on later coaches)
23. Rubber Valve
24. Fresh Water Tank Overfill Tube
25. Exhaust Fan & Motor

* Part of Optional Air Dump Valve System

Figure 17-11. Air Flush Lavatory Components.

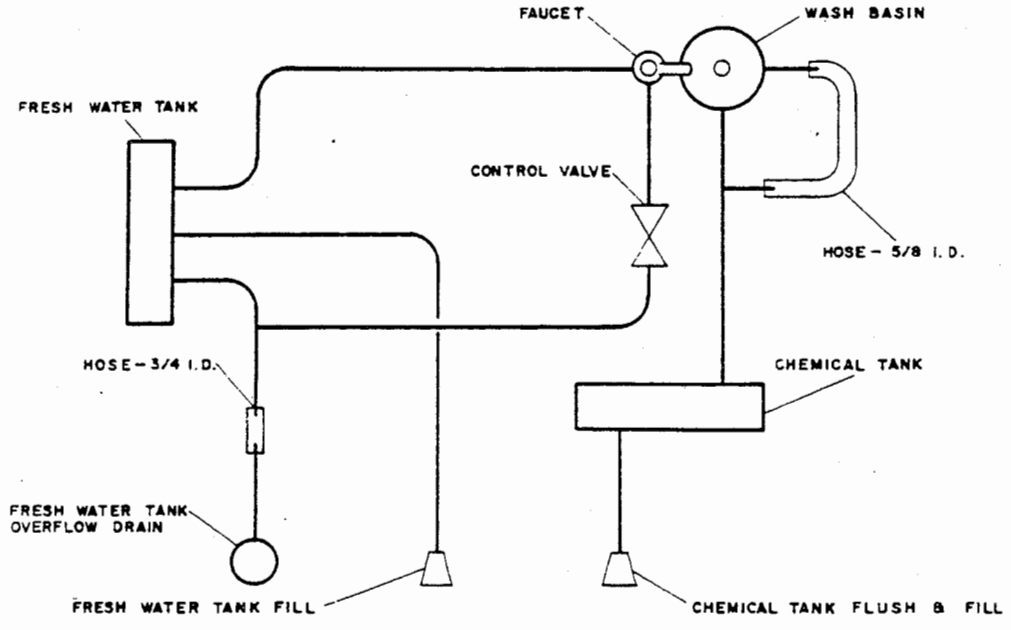


Figure 17-12. Plumbing Schematic.

CHEMICAL TANK

DRAINING CHEMICAL TANK:

1. Place coach over floor flush hopper.
2. Pull handle of slide dump valve. This completely exposes the dump tube opening and drains the contents of the tank.

NOTE: The valve should be left open until the flushing operation is performed; the chemical tank incorporates a large clean-out hole in one end for removal of wastes.

FLUSHING CHEMICAL TANK — Connect water service hose to Hansen connector to introduce continuous flushing action through chemical tank. Flush chemical tank until clean.

FILLING AND TREATING CHEMICAL TANK — Before filling chemical tank make certain that dump valve is closed.

The water supply hose is left connected to inlet until the water level can be seen in the sight gauge on the side of the chemical tank.

Pour 1/3 pint (.15 liters) of Kilgerm or equivalent disinfectant into chemical tank. This chemical mixed with water will properly treat the chemical tank. It can be obtained from:

Government Chemical Products Corporation
5511 Bellford Avenue
Cleveland, Ohio

WINTERIZING — The most economical way to protect the chemical tank, should it be exposed to extreme cold temperatures, is to use an antifreeze solution such as ethylene glycol (unless the tank is equipped with an immersion heater).

AIR OPERATED FLUSH SYSTEM

The air-operated pump is a self-contained flushing unit having one movable part, an air-operated diaphragm which is within the unit. The pump unit is mounted to the bottom of the chemical tank.

The system operates from the main air supply and pressure is reduced to 11 psi (76 kPa) by a regulator. A push button control valve is installed and when pressed will permit the regulated air pressure to operate the pump diaphragm. The diaphragm will expel sufficient water to flush the toilet bowl. The flushing cycle takes approximately 14 seconds and the recovery time approximately 10 seconds.

Flushing is accomplished by delivering water into the toilet bowl in a vigorous swirling action.

When the push button is released the quick release valve will release air from the diaphragm pump.

CHARGING SYSTEM (WARM OR COLD WEATHER)

To charge the system fill the tank with 5 gallons (19 liters) of water through the chemical tank rinse and fill fitting located above the inside right side engine compartment door. Press the control button in lavatory to flush and add the recommended 6 oz. (177 ml) of DG-19 chemical or the alternate and quantities as shown later. Flush again and the system is ready for use.

MC-9 MAINTENANCE MANUAL

The following chemicals are approved for operation in this flush system.

Supplier	Trade Name	Mixture
West Chemical Products 2110 E. 37th St. Los Angeles, Calif.	Teramine	1 U.S. pint (.47 liters) liquid chemical to 1 U.S. gallon (.37 liters) water
4216 West Street Long Island, N.Y.	Sanitor	1 oz. (29.5 ml) liquid chemical to 1 gallon (3.7 liters) water
Vapor Corp. 6420 West Howard St. Chicago, Ill. 60648	DG-19C	3 parts dry chemical to 11 parts water by volume
Leeder Chemical Co. 16220 Illinois Ave. Paramount, Calif. 90723	Commode Magic	1 oz. (28.3 grams) dry chemical to 1 gallon (3.7 liters) water

TROUBLESHOOTING

TROUBLE	CAUSE
TOILET WILL NOT FLUSH Pushbutton will not reset, air leaking can be heard.	Air line from pump assembly to control valve broken or disconnected or cracked or broken lower pan housing.
Air regulator hissing.	Defective air regulator.
Water in the air line from pump to pushbutton.	Pump diaphragm broken.
Comb stuck in up position.	Replace comb and grid, or replace conical spring if broken.
Pump is functioning but no water in the bowl.	Broken water line from pump assembly to bowl.
SHORT FLUSHING CYCLE (10 SECONDS OPTIMUM)	Bubbles in the flush pattern. Hole in the water hose from pump assembly to bowl.
Comb will not reach full height during flush cycle.	Excessive build-up of debris between pins of comb.
Water bubbling in grid area.	Defective valve in the comb housing area.
AIR BUBBLES IN THE FLUSH Water level below comb pins.	1. Recharge with water and chemical DG-19C. 2. Insufficient amount of water pre-charge. 3. Water in the air line from pump to pushbutton. 4. Small hole in the pump diaphragm.

NOTE: Periodic visual inspection should be made of the tank interior for foreign objects and/or excessive buildup in the tank corners due to lack of proper rinsing.

FILLING FRESH WATER TANK

To fill the fresh water tank the following procedure should be followed.

1. Open lavatory service door situated at the rear right hand side of the coach marked "Potable Water Supply." The fitting is accessible once the service door is opened.
2. Attach a Hansen 5000 series connector to the fitting.
3. Open the water supply and fill the tank until water flows out of the overflow line.
4. Remove fill hose and close service door.

REMOVAL

To remove the fresh water tank, the lavatory mirror will have to be removed first.

1. Remove the snap-on molding and track which holds the mirror in place around the top and sides of the mirror.
2. Pull the mirror up from behind the bottom retaining channel and carefully swing out. The fresh water tank, mountings and line fittings are now exposed.
3. Disconnect the lines and fittings, and remove the mounting hardware.

THERMAL DRAIN VALVE

Available as optional equipment is a thermal drain (Ozontz) valve which automatically drains the washroom fresh water tank when the temperature in the vehicle drops to approximately 34°F (1°C). The valve is located in the washroom below wash basin. Refer to figure 17-13.

TESTING

The following method is recommended for testing thermal drain valves:

1. After the thermal drain valve has been at room temperature for at least one half hour, pour 45°F (7°C) or warmer water into the inlet of the valve. The valve should be closed and no water should flow.
2. Place the thermal drain valve in a container of ice and cover it with a minimum of water. The water should be about 33°F (1°C).
3. After at least one half hour, remove water, remove valve and pour water from container into inlet of valve. Water should flow through discharge of valve.

MAINTENANCE

It is recommended that the thermal drain valve be inspected for leakage at outlet port located in the engine compartment once a year, preferably in the fall. The following procedure should be followed. If there is no leak, temperature above 40°F (4°C), the valve is satisfatory and needs no servicing. If a leak is evident, the following procedure should be followed:

1. Remove cap, thermal unit, cage, operating spring and bearing plate.
2. Clean seat at bottom of valve body.
3. Reassemble bearing plate, operating bearing spring, cage, thermal valve unit and cap making certain that the cage is properly aligned with the valve port and that the cage assembly is not cocked.

If the valve still leaks, the following procedure should be followed:

4. Remove cap, thermal unit and cage.
5. Remove valve guide and poppet from cage.
6. Install new Buna S poppet and re-install guide.
7. Re-install cage and a new thermal unit.
8. Re-install cap making certain that cage is properly aligned with valve port and that the cage assembly is not cocked.

NOTE: In case of a complete replacement of drain valve, make sure to seal around outlet port in engine compartment with mortite tape to prevent fumes from engine compartment entering the lavatory compartment.

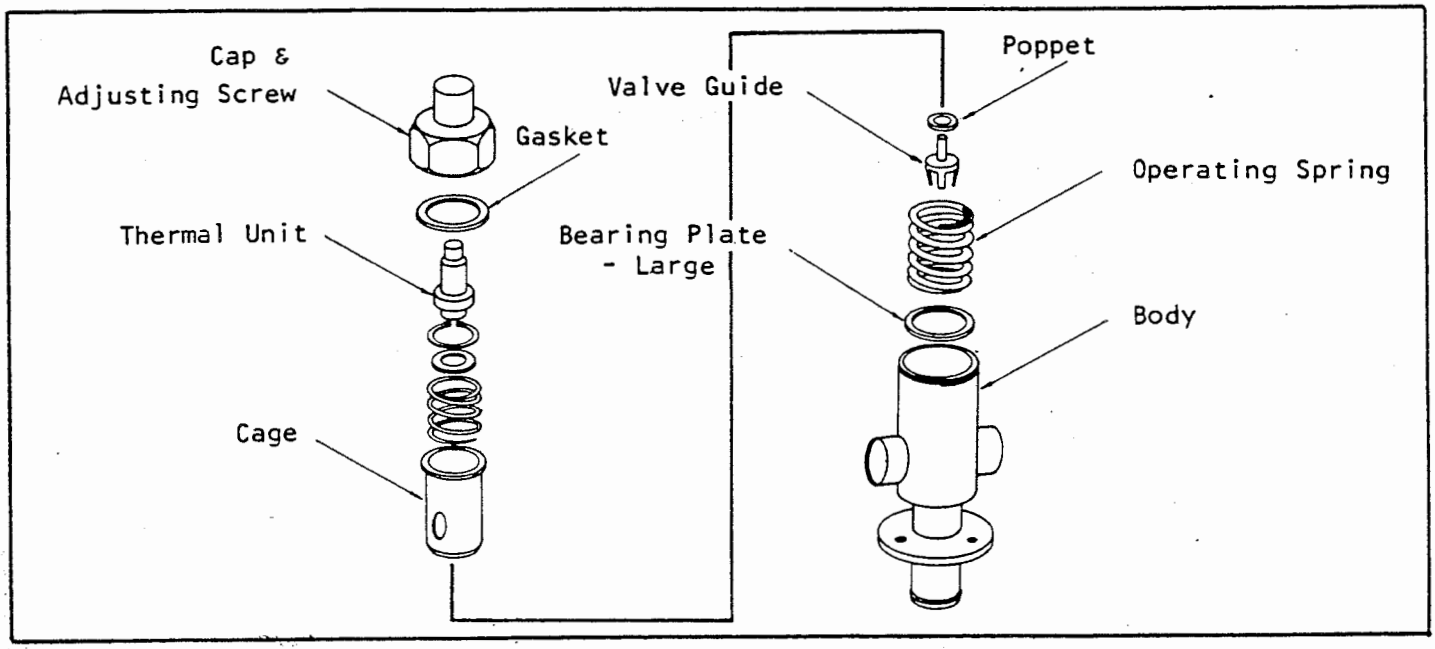


Figure 17-13. Thermal Drain Valve.

MC-9 MAINTENANCE MANUAL

SPECIFICATIONS

Chemical Tank Capacity	20 gals. (76 liters)
Chemical Tank Fill and Rinse Hansen Valve No.	6000 Series
Fresh Water Supply Fill Hansen Valve No.	5000 Series
Fresh Water Tank Capacity	10 gals. (38 liters)
Thermal Drain Valve Opening Temperature	Approx. 34°F. (1°C.)

